POWER

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# Firing Instructions

## *Hand Firing, Shaking Grate, Number Two Buckwheat Coal*

ASA P. HYDE, Chief Engineer

*As followed in the Security Mutual Life Building Plant, Binghamton, New York.*

THERE is a right time for covering the fire; find it and do it then, so far as possible, while the damper is closed. Cover one side at a time only, and that lightly. Four to six scoops is enough to cover a side.

Have the ashpit doors open when required. Doing so preserves the grates. It is well to carry some water in the ashpits, but not enough to be a nuisance in the ashes.

Keep the fire back to the inner edge of the dead plate, but have no fire or coal on it under any circumstances. Keep the floor clean. Do all shoveling from the coal car.

Do not permit the fire to burn out, or too low, or in holes to allow an inrush of cold air through the dead or low spots. Cover, generally, when the fire is near or at a white heat. Raking, digging and fussing with a fire are usually unnecessary and must not be done except in extreme circumstances. Neglect will cause these extremes.

Keep the fires level by the proper handling of the shovel. You can do it.

There can be no fixed rule when to shake and to clean fires; but it is to be done only when necessary; and this does not mean to make up for neglect.

Carry as thin a fire as practice tells you is best, taking into consideration fuel, both as to quality and quantity used. The $CO_2$ obtained will tell you this, as will the load and weather conditions. A heavy load will usually require a correspondingly heavy fire, too light a one too much excess air, too heavy, not enough air. Study the conditions and govern yourself accordingly.

When about to clean fires, do not raise the pressure because you expect to drop it again or cannot hold it. Burn the fire down, then coal lightly, and as soon as it is well ignited, clean. Push the shaking lever back, then rock it ahead to or near central, then back, doing this once or twice, depending on the conditions of the fire. This will help to break up the fire and the clinkers. Then draw the lever forward to the cutting position, then back to the center, dropping the ashes to the pit. Repeat if necessary. Do this work quickly and with the doors closed and the damper open slightly to carry off the dust. Do not cut too close, or so the fresh fire will come down onto the grates. Level the fires quickly with the hoe or rake. Cover lightly all over with fresh coal. Get the doors closed as soon as possible. Then, when the fire has burned and the damper is again closed, level with the bar or rake, if necessary.

So manage the fires as to keep the damper partly closed. Besides the main damper and regulator, use the hand-operated uptake damper on each boiler. Get the heat in the arches, into the boiler, not up the stack.

Wet the ashes in the pit just enough to hold the dust. Load the ash cans evenly so as to get a fair estimate of the weight. Have a continuous feed. Carry about 4 in. of water in the glass and keep it there. Blow the columns and glass regularly and know they are all right.

Watch the boiler shell, walls, arches, grates, steam and water lines, etc., and report them if anything is needed or is irregular. Carry a uniform steam pressure.

We shall at all times to the best of our ability provide the best and cheapest fuel, this being determined by the operating results. This requires your co-operation both in the use of the fuel and in carefully and understandingly handling and checking it.

Smoke can be almost entirely prevented by using good judgment. Fire only when a fire is ready and conditions tell you it is the time. This you must learn. Fire only one side at a time. In this way the gases from the fresh fuel will be ignited by the live fire and burned in the combustion chamber, producing a good $CO_2$ chart. No one can tell you all the kinks which go to make successful firing possible. You must study and read and watch for results. Note carefully what each change or method produces in the results, with different boilers, different conditions and especially different fuels.

The company has a right to, and does, expect the man or men in charge of the boilers to be careful, conscientious and saving in labor and material.

Read and study books and papers in the engineering line, a large supply of which we have and will furnish you if you will use them. Do not be content to be a coal shoveler; be a fireman on your way up to a better position.

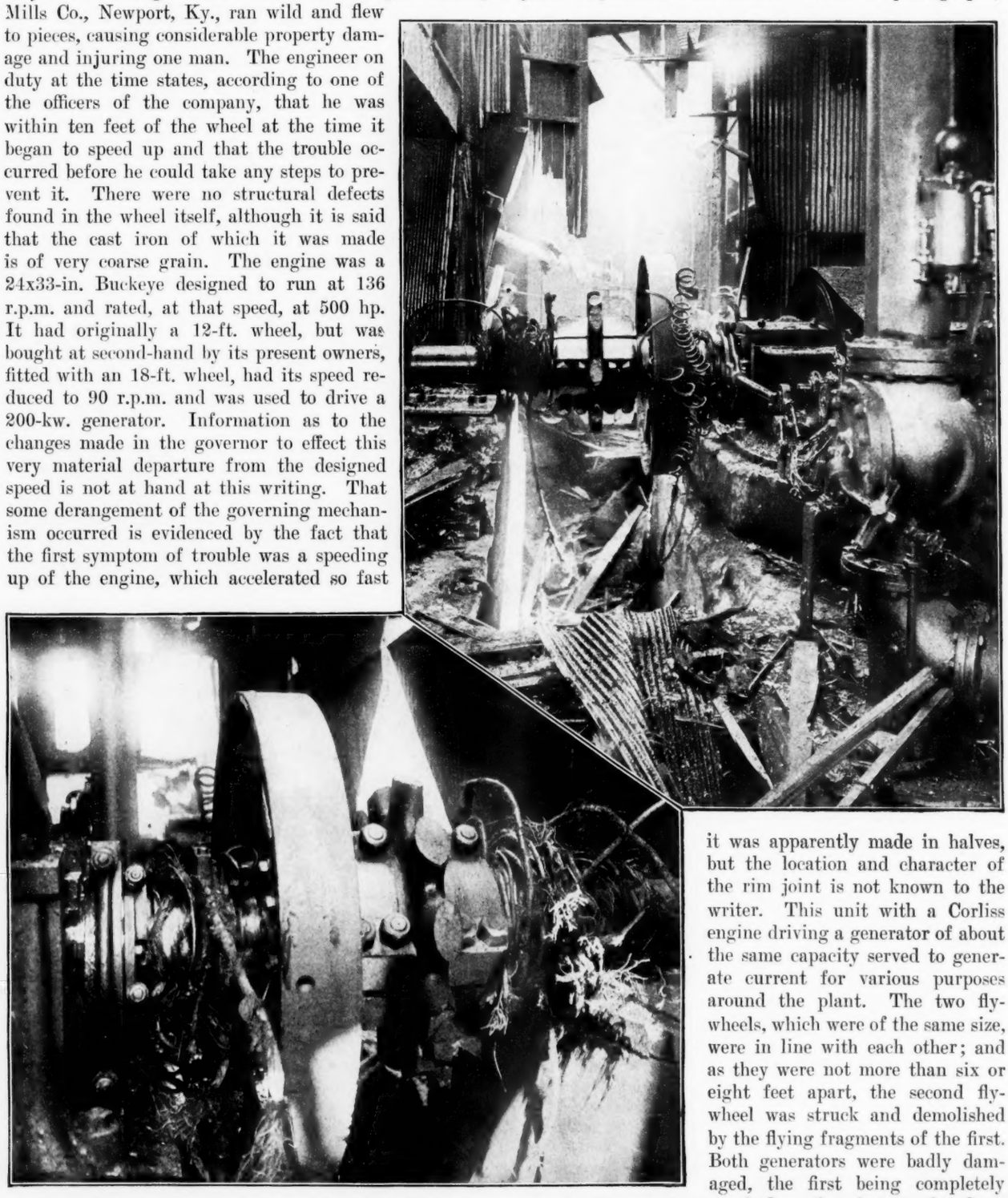
With our combined efforts we can make our plant pay better and be a credit to all. I know that you will do your part. Depend on it, the department will co-operate.

# Flywheel Bursts at Newport, Ky.

*SYNOPSIS—Engine designed to run at 136 r.p.m. with a 12-ft. flywheel made over to run at 90 runs away and bursts its 18-ft. wheel.*

Early on the morning of Thursday, Oct. 12, and fortunately at a time when there were few men in the plant, a flywheel in the generator room of the Newport Rolling Mills Co., Newport, Ky., ran wild and flew to pieces, causing considerable property damage and injuring one man. The engineer on duty at the time states, according to one of the officers of the company, that he was within ten feet of the wheel at the time it began to speed up and that the trouble occurred before he could take any steps to prevent it. There were no structural defects found in the wheel itself, although it is said that the cast iron of which it was made is of very coarse grain. The engine was a 24x33-in. Buckeye designed to run at 136 r.p.m. and rated, at that speed, at 500 hp. It had originally a 12-ft. wheel, but was bought at second-hand by its present owners, fitted with an 18-ft. wheel, had its speed reduced to 90 r.p.m. and was used to drive a 200-kw. generator. Information as to the changes made in the governor to effect this very material departure from the designed speed is not at hand at this writing. That some derangement of the governing mechanism occurred is evidenced by the fact that the first symptom of trouble was a speeding up of the engine, which accelerated so fast that according to the engineer on duty it was impossible to shut it down before the crash came. The condition of the throttle suggests the fate that would have come to one who tried. There was no load on the engine at the time.

The broken wheel was 18 ft. in diameter, which at 90 r.p.m. would give it a rim speed of about 85 ft. per sec. The face was 23 in., 4.5 in. thick at the edges, with 12 spokes elliptical in cross-section. From the photographs, it was apparently made in halves, but the location and character of the rim joint is not known to the writer. This unit with a Corliss engine driving a generator of about the same capacity served to generate current for various purposes around the plant. The two flywheels, which were of the same size, were in line with each other; and as they were not more than six or eight feet apart, the second flywheel was struck and demolished by the flying fragments of the first. Both generators were badly damaged, the first being completely wrecked as the photographs show.



VIEWS OF WRECKED ENGINE; NOTE REMAINS OF GENERATOR

# Centrifugal Boiler-Feed Pumps

By Otto Haentjens and Edward F. Barrett

*SYNOPSIS—Some centrifugal pumps are not properly designed for boiler feeding, and in this article are described some of the features of construction necessary in a centrifugal pump in order that economical operation may be obtained.*

In power plants having capacities of over 1,000 boiler horsepower direct-acting and power-driven triplex boiler-feed pumps are being displaced by turbine- or motor-driven centrifugal pumps. The centrifugal pump is now well beyond the experimental stage, and properly designed, it is as reliable as the plunger type.

The direct-acting pump is sometimes preferred on account of its low first cost, when its wasteful operation is

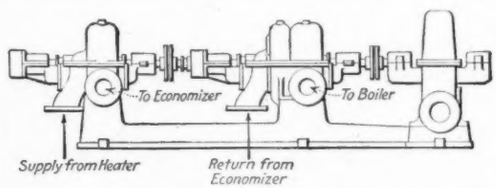



FIG. 1. TWO PUMPS IN SERIES WITH ECONOMIZER

not considered. The triplex pump, when driven by a variable-speed direct-current motor, is efficient, although it requires considerable space and attention and the noise of the gears is objectionable; but if driven by a constant-speed motor, it is efficient only when delivering the full pump capacity for that speed, because at light loads a part of the water must be discharged back into the suction of the pump and greatly decreases its efficiency. All triplex pumps must be equipped with relief valves capable of discharging the maximum capacity of the pump.

The motor-driven centrifugal pump is not as efficient for boiler feeding as the triplex pump when both are operating at maximum efficiency, and like the triplex pump it has the disadvantage that when operating at light loads, part of the work done by the pump must be destroyed by throttling. The characteristic head curve of a motor-driven centrifugal pump should be flat, and it should also have a flat efficiency curve. Pumps having these characteristics have usually a rising horsepower curve; that is, the power increases rapidly as the pressure decreases, and consequently the motor should be large enough to carry this load or be equipped with an overload release. The motor-driven centrifugal pump has the advantage of requiring little floor space and attention, and it runs almost noiselessly.

The steam-turbine driven centrifugal pump is probably the best all-around machine for boiler feeding. It is not as efficient as a motor-driven pump when the latter is running at its most efficient capacity, but its over-all efficiency will be approximately the same for any load; and it has so many other advantages over all other types, including a steady discharge without pulsations in the feed line, that there seems to be no doubt that it is the ideal machine for boiler feeding.

The steam-driven pump is usually equipped with a water-pressure governor regulating the speed of the turbine and adjusts it automatically to any load. The pressure never exceeds that for which the governor is set, obviating excessive pressure that tends to cut the valves in the feed line, if they must be partly closed to check an excess pressure. If the feed passes through an economizer, an excessive pressure may cause the tubes to burst, and efforts have been made to relieve the economizer of this high pressure. Usually two pumps are mounted on one base with the turbine or motor on one end, as in Fig. 1. The first pump may be a volute or a single-stage turbine, and this is to be preferred, as the impellers and diffusers in both pumps can be made interchangeable. This first, or low-pressure, pump takes the water from the heater and delivers it through the economizer to the suction of the second, or high-pressure, pump. As the water is then hot, the pressure must be high enough to prevent it from steaming and to overcome the friction loss in the economizer.

It is advisable to have one flexible coupling between the turbine and the high-pressure pump and one between the high- and the low-pressure pump. The temperature in the high-pressure casing is much higher than in the low, and if the shaft is made in one piece with one bearing between the high and the low-pressure casing, the bearing may be thrown out of alignment by the difference in the expansion of the casings.

A set of this kind can be simplified by a special casing with a discharge coming out on the first stage and one on the last stage, and with one suction leading into the first impeller and one leading into the second impeller. With this type of construction, (Fig. 2) the casing will

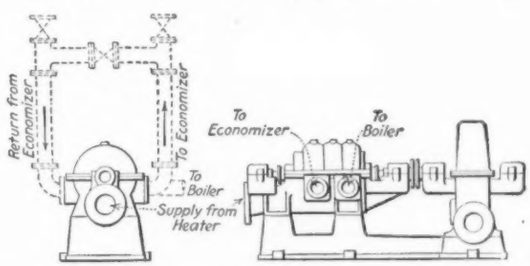



FIG. 2. SELF-CONTAINED TWO-PART TANDEM PUMP

have a more uniform temperature. Two stuffing-boxes, two bearings and one coupling are dispensed with, and the unit requires less floor space.

The capacities of centrifugal boiler-feed pumps range from 80 to 1,200 gal. per min. For smaller pumps the efficiency is too low and the cost too high as compared with a duplex pump. There are boiler-feed pumps in operation having a capacity of 1,500 gal. per min. and over, but it is not likely that such installations will be duplicated, because smaller units give more flexibility, and in case of a breakdown the operation of the plant is not seriously interfered with.

Turbines direct-connected to smaller centrifugal boiler-feed pumps are usually of the impulse type with velocity stages. As a rule, the higher the speed the higher the efficiency of the turbine will be. In Europe turbines ranging from 5,000 to 6,000 r.p.m. and pumps of the single-stage volute type are used. The peripheral speed of the impeller is extremely high, and the impellers and

pump casings are made of special hard bronze. This makes a compact and light pumping unit, as shown in Fig. 3, but the high speed requires close attention to the pump end especially.

Engineers contend that the trouble likely to be caused by this high speed offsets its advantages, and 4,000 r.p.m. is considered the maximum safe limit. They also object to the European design of the pump, which has a solid casing with a solid suction head so that the suction pipe has to be disconnected before the suction head can be taken off and the impeller inspected. The American practice of using a horizontally split casing with suction and discharge connections at the bottom half is much to be preferred, as the top half of the casing can readily be taken off to examine the interior of the pump.

Pumps having a capacity of less than 500 gal. per min. should have solid diffusion rings, but in the larger units the diffusion rings should be split horizontally, so that the upper half can be taken off the same as the upper half of the casing. A split diffusion ring is likely to leak, to some extent and the smaller the capacity the greater the percentage and the more effect a given leakage will have on the capacity and efficiency of the pump. Consequently it is best not to split the diffusion rings of small pumps.

Feed pumps without diffusion rings are not efficient as the head per stage is high (usually 150 to 200 ft.) and if the impeller is surrounded by an annular chamber and discharges directly into this chamber, the shock losses increase with increased head. In a volute chamber the velocity of the water can be kept higher than that in an annular chamber, therefore the shock loss is less and the efficiency of the pump is higher. If the diffusion ring is omitted, the casing diameter is considerably reduced and the pump is less complicated and cheaper to build, but less efficient. Efforts have been made to increase the efficiency of these pumps by the use of vanes put into the return channel leading from the annular chamber to the suction of the next impeller. While at first glance it

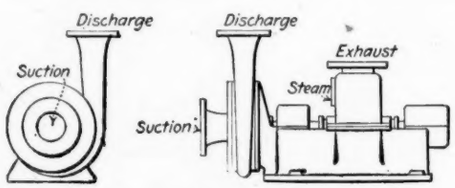



FIG. 3. COMPACT HIGH-SPEED SET

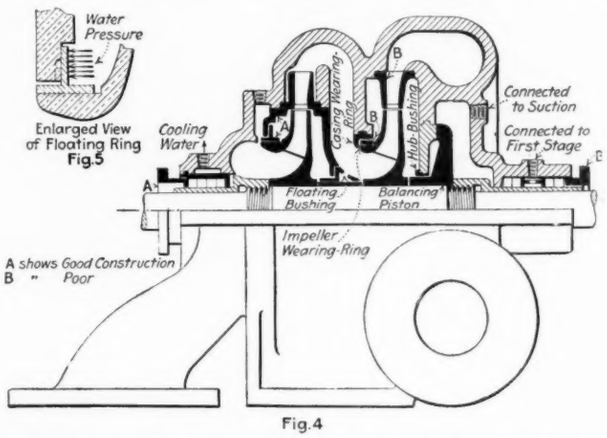
seems a paradox that the velocity head could be changed into pressure by leading the water from the periphery of the impeller toward its center, yet it has been demonstrated by tests that to a certain extent this can be done; but it was also found that it was almost impossible to predict the performance of such an impeller and the best efficiency obtained was far below that of pumps having diffusion rings. Pumps without diffusion rings are being sold and with a high efficiency guarantee, but the customer as a rule does not have the means or opportunity to test the pump, and, in the opinion of the authors, the manufacturer "takes a chance."

The life of a diffusion-ring pump depends on good material and workmanship. They must be of brass or brass faced, so that they cannot rust in, and must fit snugly into the casing, for if water leaks around the face of the rings, it will eat away the cast iron and eventually the leakage will increase to such an extent that it will be necessary to rebore the casing. The casing fit should be kept as small in diameter as possible, and Fig. 4 shows how it can be reduced if the diffusion ring is properly designed.

A boiler-feed pump should be inspected every three months, and if feed water is used that will form a scale in the pump, it is important that it be removed.

Bronze diffusion rings are generally used because the tips of cast-iron rings corrode quickly and the pump efficiency drops.

Impellers should also be made of bronze, and if the openings are less than ⅜ in. impellers and diffusion rings




FIGS. 4 AND 5. SHOWING FLOATING WEARING RINGS

should be made in two pieces riveted together, because small impellers and diffusion rings require a good finish, and if the openings are narrow it is difficult to get at the inner surfaces with a file. One of the most important parts of the whole pump is the impeller wearing ring. On small pumps especially, the clearance between impeller and casing wearing ring must be small to prevent excessive leakage and there must be little wear at this point. All pumps should have casing wearing rings, and all parts subject to wear should be interchangeable. Many customers require that impellers also have renewable rings, in order that they may carry a number of casing and impeller wearing rings in stock and install them when needed. The wearing ring is usually forced or shrunk on the impeller. This is a difficult job and must be done with great care or the ring will come off when the pump is in operation and damage it, as has happened frequently, their peripheral speed being sometimes as high as 100 ft. per sec. Considering this and the expansion due to the high temperature of the water, it is better not to put a wearing ring on the impeller. The impeller hub should be thick enough to allow for turning down or truing up, and the casing rings, if carried in stock, should be only rough-bored, and after the hub is trued up, the ring should be bored to fit the impeller. Even when impeller wearing rings are used, it is necessary to put the rotor in a lathe in order to true up the rings after they are forced or shrunk on. Therefore it will be seen that repairs can be more quickly made if impeller wearing rings are not used. Casing and impeller wearing rings are shown in Fig. 4 to make the foregoing clear.

Most designers provide a straight stationary casing wearing ring and specify a clearance of about 0.004 in. between the impeller and casing wearing rings, but if the impellers do not run absolutely true or if in starting up

the shaft vibrates. The impeller will rub against the stationary rings and wear rapidly or "freeze." This is also true of labyrinth rings, so pump manufacturers always caution customers not to start the pump before it is primed so that the water may act as a lubricant. Nevertheless it is often done, either through carelessness or ignorance, when a new man tries to run the machine. It is a difficult job to properly erect a three-stage pump that has only 0.004 in. clearance between the impeller and the wearing rings, and no matter how heavy the base is made, it may spring when attaching the steam and water pipes. In most high-speed pumps the shaft is not heavy enough to prevent vibration before the pump comes up to full speed, or in other words when the machine runs between the first and second critical speeds. This can easily be proved with a balancing machine. There is also an uneven expansion of the casing, caused by the hot water, and in order to prevent accidents, hot-water pumps are given more clearance—usually 0.01 or more—which means increased leakage and reduced efficiency.

These troubles can, however, be overcome by the use of floating wearing rings, as shown in Fig. 5. These rings are of ⊥-section and are fitted on the impeller hub with about 0.004 clearance in diameter. When the pump is insufficiently primed or started without water in the casing, the rings rotate with the impellers, but when a pressure is created in the casing the rings are forced against the casing wearing rings, and the friction between these rings and the floating rings becomes so great as to stop the latter from rotating. They can then be considered as part of the casing wearing rings or diffusion rings. They center themselves around the impeller, a film of water keeping them apart, and by this action imperfect machining or erecting is overcome. These rings wear very little and wear evenly, and they will last generally from one to two years.

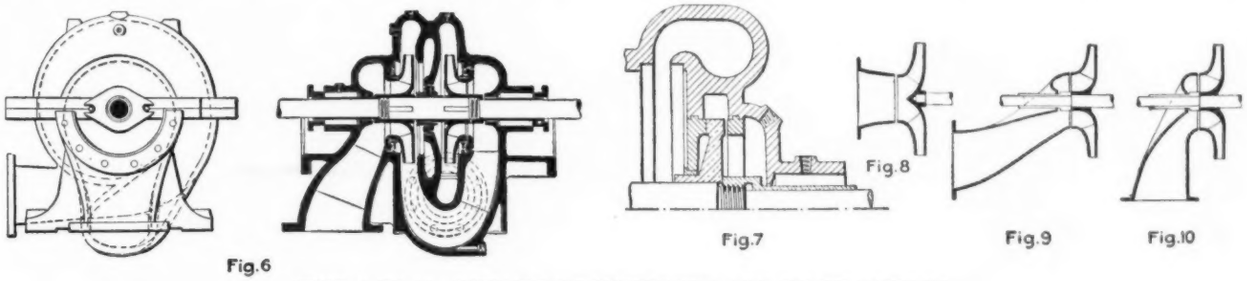
The stage-piece bushing rings are likely to freeze or wear rapidly and, consequently, they should be made floating and self-centering in the same manner. The floating rings and stage-piece bushing rings should be made of soft bronze and the parts on which they run of hard bronze.

A centrifugal pump should have the minimum number of parts that are likely to wear. A two-stage single-suction pump with opposed impellers has only two impeller rings and one stage-piece bushing ring, as shown in Fig. 6, and is theoretically balanced, but a small thrust bearing is usually furnished, as the first stage may become vapor bound and the pump is then no longer balanced. The thrust bearing cannot sustain the load for long and will burn out.

The single-suction centrifugal pump with impellers in series has only one impeller ring and one stage-piece sleeve per stage and if hydraulically balanced by means of a balancing piston of the proper diameter, as shown in Fig. 4, is a good design. At high speed the disk consumes considerable power, and the efficiency of the pump will drop as the wear of piston-hub bushing increases. The disk can be built double-acting with two wearing faces, as shown in Fig. 7. This will prevent excessive leakage, for when the piston is moving away from one face, it comes closer to the other, throttling the flow.

There must always be enough leakage to have a film of water constantly passing between the face of the piston and the stationary ring, and the faces must be machined absolutely true, or the surface will be cut. All pumps equipped with a balancing piston have the advantage that vapor in the first stage does not disturb the balance, and that the stuffing-box on the discharge side is under the same pressure as the one on the suction side. This eliminates the troubles caused by stuffing-boxes under high pressure.

Some engineers believe that a double-suction pump makes a better boiler feeder than the single-suction pump. This belief is based on the fact that many of the pumps first brought out gave all kinds of trouble, but they were due principally to the incorrect design of the casing suction head and the impeller inlet, and in many cases the heater was set too low.




FIGS. 6 TO 10. DETAILS OF IMPELLERS AND INLET NOZZLES

Fig. 6—Two-stage pump with opposed impellers. Fig. 7—Disk with two wearing faces. Figs. 8 to 10—Shape of various inlet nozzles

High speed requires high water velocity into the impeller, and the pressure at the suction must be sufficient to produce this velocity and to prevent the hot water from steaming. There should be at least eight feet effective head at the impeller inlet when the pump is running and handling water at 212 deg. F., and it would be better to have ten or twelve feet head. In laying out a boiler plant it is advisable to use the following figures:

| Water Temperature | Effective Head on Pump |
|---|---|
| 160 deg. | 0 ft. |
| 180 deg. | 5 ft. |
| 200 deg. | 9 ft. |
| 212 deg | 12 ft. |

The capacity at a certain speed depends on the velocity at which the water flows into the impeller and the latter in turn depends on the shape of the suction head or inlet nozzle. A straight suction nozzle (Fig. 8) gives the best results, and a short bend (Fig. 10) the poorest, and Fig. 9 is a compromise between the straight nozzle and the short bend. With a properly shaped suction head, 600 gal. per min. can be handled by a single-suction impeller running at 3,000 r.p.m.; for high speeds and capacities above 600 gal. per min. double-suction pumps are recommended. They are hydraulically balanced, but are as a

rule equipped with a thrust bearing for emergency, as before stated, and give good efficiency when equipped with diffusion rings. The distance between impeller center lines is greater in double- than it is in single-suction pumps, and the shaft therefore is longer. The impellers are also heavier than in the single-suction, and this with a greater distance between bearings requires a heavier

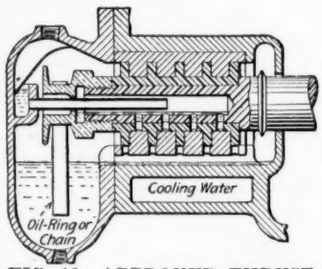



FIG. 11. APPROVED THRUST BEARING

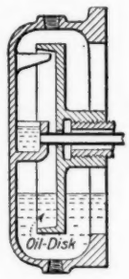



FIG. 12. OIL DISK NOT SATISFACTORY

shaft. There are two impeller wearing rings and one stage-piece bushing ring for every stage, and the stuffing-box on the discharge side is under the pressure of the next to the last stage.

Thrust bearings for high-speed pumps should not have an oiling device that churns the oil and creates heat. If the oil is churned, it gets foamy and loses its lubricating qualities. Oil impellers and disks running in the oil create heat and should not be used. Oil rings as used on the line bearings (Figs. 11 and 12) give much better results. The lower half of the thrust bearing should be water-jacketed to cool the oil, but it is not necessary to water-jacket the bearing cap; besides this introduces a troublesome joint and water may leak in and spoil the bearing.

The stuffing-boxes usually have a water-seal fitting which is connected to the first stage, but there is no good reason for doing this, because the water should always come to the pump under a head, and therefore air cannot leak into the casing. It is not good practice to use the water from the first stage to lubricate the packing, as it is too hot. It is much better to provide cold water for the seal, or to leave the water seal out and provide a water jacket around the stuffing-box. This will keep the packing and the shaft cool. A water cooled stuffing-box is shown on the suction side in Fig. 4. The gland should not be pulled up too tight so that a little water may leak out to lubricate the packing and preserve it. The best of packing should be used. The gland should be made so that if it is drawn up carelessly in an uneven manner, it will not touch the shaft. This is accomplished by having little clearance between the gland and casing and considerable clearance between the gland and the shaft. The glands should be carefully attended to, and the packing should not be left in the pump too long. A well-designed and a poorly designed gland are shown in Fig. 4.

Bearings and bedplates should be of substantial design, and when erecting the pump, it should be leveled up carefully, and secured before the steam and water pipes are connected. The pipe flanges should line up exactly before the bolts are drawn up, for if this is not done the base will be thrown out of alignment. It is surprising that even in large power plants this rule sometimes is entirely disregarded. The centrifugal pump is a high-speed machine, and it is particularly important that careful attention be given to the installation of the unit. By holding a straight-edge over the coupling faces, the alignment can easily be checked.

If properly installed and carefully handled, a well-designed centrifugal pump will give no trouble, but if handled in a careless manner there will be trouble. The engineer who studies his machines and knows their construction and is careful to see that they are properly installed and handled is an enthusiastic advocate of the centrifugal boiler-feed pump.

Reciprocating apparatus is at a disadvantage as compared to turbine drive when superheated high-pressure steam is used. The turbine drive has other advantages, such as absence of water-hammer, clean exhaust steam, small floor space and small upkeep cost.

# Triplicate Sampling of Coal

By W. D. Stuckenberg*

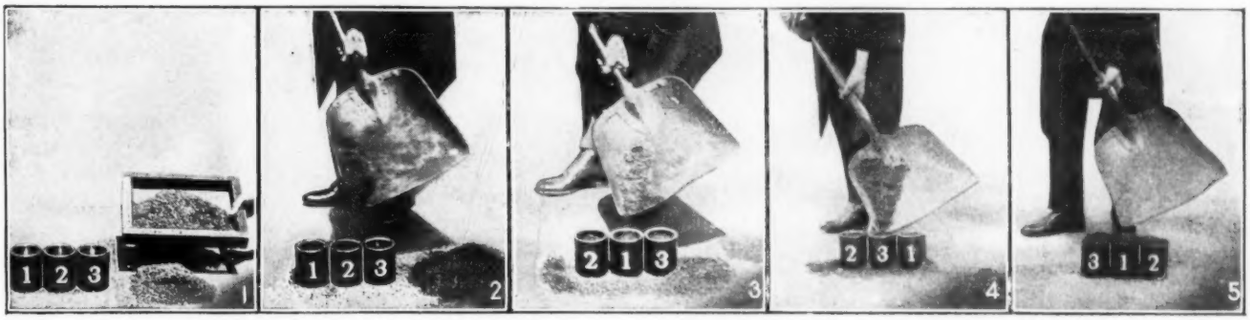
*SYNOPSIS—By properly filling the three receptacles the samples will check within 1 per cent. Proper and improper methods of filling illustrated.*

Many times the assertion has been made that chemists do not check on duplicate or triplicate samples of coal for analysis. The arguments that have been brought forth on this subject are numerous. Some are well founded, while others are erroneous. The assertion is correct when the equipment in the laboratory is not up to standard and the men doing this work have not had the technical training and experience necessary. When the work in a laboratory is carefully and conscientiously done by thoroughly competent and experienced men, with equipment that has been standardized and of an efficient type, the indications are that analyses will check, and check closely (within 1 per cent.) when the samples are prepared properly.

Many coal contracts state that analyses are to be made to determine the dollars and cents value of the fuel. They state further that triplicate samples are to be taken—one given to the consumer, which will be analyzed and reported; the second given to the coal company and the third sealed and kept for future check purposes, if needed. So far as the check of the quality of coal contained in these three cans is concerned, it all depends upon the manner in which the sample is prepared and placed in the receptacles. In many instances the method of this preparation and the filling of the cans or jars are left to the discretion of an experienced man. This is the chief reason why a discrepancy occurs and why the findings of two or three laboratories will not check.

*President, Commercial Testing and Engineering Co., Chicago.

Pictures showing each step in the preparation of a sample for the laboratory have been presented recently in these columns (*Power*, June, 20, pp. 864 and 865). The accompanying illustrations, Figs. 1 to 5, show how three receptacles should be filled for check purposes. It is essential that the sample of coal be reduced in size so that all pieces will pass through a six-mesh screen, the holes of which are approximately $\frac{5}{32}$ in. square. This screen is obtainable at a hardware store and can be tacked to the bottom of a wooden frame. The gross sample should be reduced in size by a series of crushings, mixings, quarterings and by eliminating diagonally opposite quarters until there remains approximately enough to fill the three receptacles. This remaining coal, if crushed properly, should easily pass through the six-mesh screen. Fig. 1 shows the screen and a sample being sifted through it. Any particles riding on top of the screen should be put to one side and crushed finer until they will pass through. This sample should be thoroughly mixed by shoveling over and over again in a cone-shaped pile. The sample is then ready for equal distribution into the three receptacles. The actual performance of this is shown in Fig. 2, where the cans are placed side by side and numbered 1, 2 and 3. All of the coal sample should not be taken in the shovel at once, for if this is done it will fall off in a broad, uneven stream. Only enough should be taken so that it will form a small stream as it passes from the corner of the shovel. The shovel is moved rapidly across the three receptacles, so that there will be an even distribution of the coal in the three cans or jars. The blur seen in Fig. 2 is the coal falling from the shovel into the receptacles as the camera was snapped. This was done purposely in order to show the general motion or scattering of the coal. About one-fourth of the coal has thus been placed in the receptacles by this first operation. The coal that naturally falls on the floor around the receptacles should be gathered up and placed with the remainder of the sample. The position of the receptacles should then be changed so as to place the one that was in the middle on one of the ends, as in Fig. 3. Then another quarter of the coal should be taken in the shovel and again scattered across the receptacles. This process of changing the positions of the receptacles should be repeated until the cans are finally filled, as in Fig. 5.




FIGS. 1 TO 5. SHOWING SUCCESSIVE STEPS IN TRIPLICATE COAL SAMPLING

If proper care is taken to fill the cans and change their positions as described, the indications are that analyses will check, assuming that the laboratory work is done properly. The following figures bear this out:

FIGS. 6 TO 8. GOOD AND BAD METHODS OF FILLING CANS IN TRIPLICATE SAMPLING

| | Moisture | Dry Ash | Dry B.t.u. |
|---|---|---|---|
| First laboratory, sample A | 13.24 | 20.33 | 11,440 |
| Second laboratory, sample A | 12.93 | 20.70 | 11,538 |
| Difference | 0.31 | 0.37 | 98 |
| First laboratory, sample B | 12.03 | 18.40 | 11,813 |
| Second laboratory, sample B | 12.02 | 18.85 | 11,845 |
| Difference | 0.01 | 0.45 | 32 |
| First laboratory, sample C | 12.45 | 20.46 | 11,426 |
| Second laboratory, sample C | 12.09 | 21.33 | 11,467 |
| Difference | 0.36 | 0.87 | 41 |
| First laboratory, sample D | 12.22 | 13.52 | 12,426 |
| Second laboratory, sample D | 11.76 | 13.90 | 12,406 |
| Difference | 0.46 | 0.38 | 20 |
| First laboratory, sample E | 6.91 | 8.96 | 13,216 |
| Second laboratory, sample E | 6.99 | 8.48 | 13,198 |
| Difference | 0.08 | 0.48 | 18 |

Five samples combined together analyzed as follows: Moisture, 11.35; dry ash, 16.93; dry B.t.u., 11,851. Then taking each duplicate sample of the composite result and analyzing separately, the following results were obtained:

| | Moisture | Dry Ash | Dry B.t.u. |
|---|---|---|---|
| | 8.64 | 15.46 | 11,986 |
| | 8.90 | 14.65 | 12,155 |
| | 10.28 | 15.39 | 12,123 |
| | 15.45 | 20.41 | 11,096 |
| | 14.17 | 18.83 | 11,620 |
| Average... | 11.49 | 16.95 | 11,796 |

Averages of the foregoing five separate duplicate samples show but slight differences from the composite sample.

Again, five samples were combined and run for ash only, the result being 18.07. Then separate runs were made on the duplicate samples, giving 20.60, 18.95, 14.55, 22.28 and 14.09 for an average of 18.09. The average is very close to the composite.

Samples have been taken in triplicate as shown in Fig. 6. All of the coal is taken into the shovel and emptied directly into the cans. Fig. 7 illustrates another method in which the coal was gathered up by the hands and each can filled separately. Fig. 8 represents a decidedly poor preparation of the sample. Using this method is only a waste of time when accuracy and the truth as to the quality of the coal are desired.

These last three pictures are shown in contrast with the proper method. Accuracy depends upon the proper preparation of the sample before it is delivered to the chemist. No matter how fine the equipment or how careful the experienced chemist may be, he can hardly hope to check closely when the samples are prepared as in Fig. 8.

Equipment in the laboratory must not, of course, be overlooked, for there are different makes of calorimeters and other instruments that are not of the highest possible standard. However, where the work is carefully done, according to standard methods prescribed by authorities in this special line of analytical work, two laboratories can check within 1 per cent.

# Synchronous Converters--II

By F. A. Annett and Gordon Fox

*SYNOPSIS—An explanation is given why changing the number of phases in a rotary converter changes its capacity and how, in this type of machine, when the value of the field current is changed, the armature takes a different angular position that maintains the field strength approximately constant.*

From an examination of Figs. 17 to 20, it will be readily understood why the same rotary converter operating three-phase will have a greater capacity than operating single-phase, two-phase greater than three-phase and six-phase greater than a two-phase machine. The current from the alternating-current side flows from the collector rings into the tap coil through a portion of the armature conductors to the nearest direct-current brush.

In Fig. 17 twice in every revolution the current in flowing from the collector rings to the direct-current brushes will have to pass through two armature coils only. Consequently at this position the only current flowing in the remainder of the armature coils will be that necessary to supply the no-load losses in the machines. Therefore the heating in the armature will be at a minimum. At any other position the current in flowing from the collector rings to the direct-current brushes will have to pass through a portion of the armature winding. The greater the number of coils the greater the heating.

In the three-phase machine, Fig. 18, although two collector rings never come in contact with the direct-current brushes at the same time, there are three times in each revolution that a condition exists similar to that shown in the figure. The current in flowing from the collector rings to the direct-current brushes will have to traverse only two small sections of the armature winding in parallel, which make the losses less than in a single-phase machine.

In the two-phase machine, Fig. 19, four times in each revolution the tap coils will be inserted between the collector rings and the direct-current brushes. Consequently the current will traverse a smaller number of armature coils than in a three-phase machine, causing the heating losses to be less and giving a greater capacity to the machine. Applying the same course of reasoning to the six-phase machine, Fig. 20, it is seen that six times in each revolution the current in passing from the alternating to the direct-current circuit has to flow through the tap coil only. Hence this type will have more capacity for given dimensions than the two-phase.

It will be seen that as the armature conductors move with respect to the fixed poles and brushes, at certain positions a given tap coil itself is a commutated coil under the brushes. At this instant the alternating current flows through the tap coil alone directly to the direct-current brush. At other instants the tap coil is located between brushes and it is necessary for the current to traverse several armature coils, including the tap coils, in order to reach the brushes. At every instant, then, the tap coil carries the load current while the intermediate coils carry the load current in varying degrees depending upon their proximity to the tap coils and their instantaneous positions with respect to the brushes. This should make it evident that, in so far as load current is concerned, the tap coils, carrying the load current continuously, work harder than the intermediate coils, which carry the load current only intermittently. The tap coils thus tend to heat more than other armature coils. It is evident that the larger the number of tap coils the smaller the number of armature coils that will be traversed in reaching a brush, consequently the armature resistance loss and heating will be less.

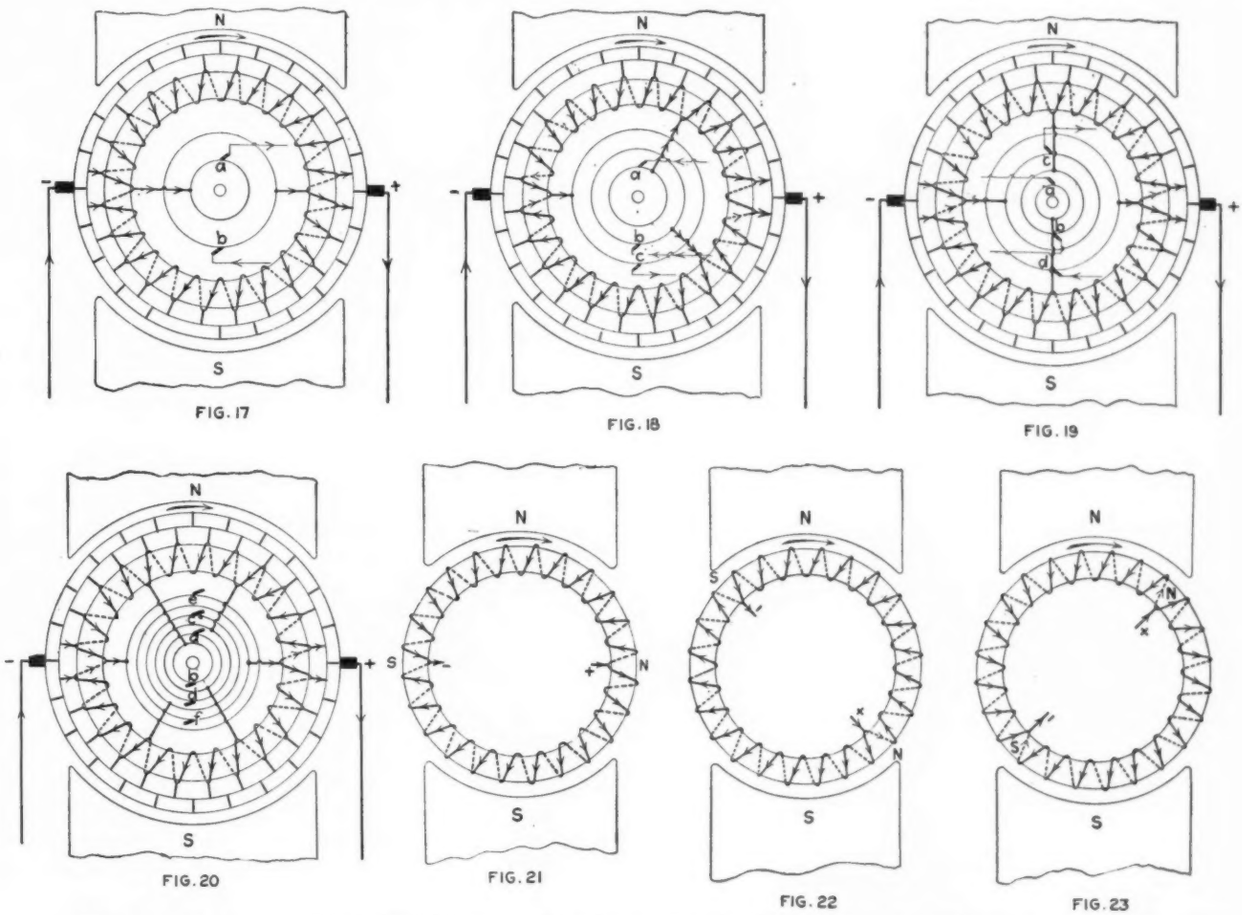
Taking the direct-current generator rating of a rotary converter as 100, its rating as a single-phase converter at unity power factor will be 85, three-phase 134, two-phase 165 and six-phase 197. For this reason most rotary converters operate from six-phase circuits.

The rotation of a rotary converter is caused by synchronous-motor action. The ordinary synchronous motor is of the revolving-field type, whereas the rotary converter is a stationary-field, revolving-armature machine. However, the action is the same in either case.

The only mechanical resistance to rotation in a converter is caused by windage and bearing friction, representing a light-load condition. In order to provide the necessary mechanical torque to produce rotation, a small alternating current flows through the armature conductors from tap to tap, this current being independent of the load current. The magnitude of this motor current is determined by the difference between impressed alternating voltage and generated alternating counter-voltage. The counter-voltage must be maintained at a value that will just allow the required motor current to flow. Maintenance of the counter-voltage at a fixed value requires that the field flux remain constant. A change of field excitation is therefore counteracted by a wattless current in the armature, which magnetizes or demagnetizes the field poles. A leading current demagnetizes the field poles when they are overexcited, and a lagging current magnetizes the field poles when they are underexcited.

It is a fact familiar to all that a lagging current is required to magnetize a field. For instance, the current that magnetizes the rotating field of an induction motor is a lagging current. The converter armature tends to maintain a field of fixed value in the same way that the stator flux of an induction motor is held constant. If the field is sufficiently strong, the armature need exert no magnetizing influence to set up its own field. There is then no wattless current taken from the line. If the field excitation is excessive, a wattless counteracting or demagnetizing current flows through the armature. A demagnetizing current is a leading current, consequently overexcitation causes a leading current to be drawn from the alternating-current lines. Conversely, if the field excitation is not equal to that demanded to maintain the counter-voltage, a portion of the magnetizing force must be furnished by the armature. Since a magnetizing current is lagging, underexcitation will cause a lagging current to be drawn from the alternating-current lines. It is evidently possible to control the power factor of a rotary converter so that it may be unity or so that either leading or lagging current may be drawn from the mains. This is an important feature in connection with rotary-converter operation.

The torque that rotates the armature of a rotary converter is produced through the agency of the motor current in the armature reacting upon the magnetism of the field pole. The magnitude and effectiveness of this reaction depends upon the relative position of the armature conductors with respect to the field pole at the instance that the motor current in the armature conductors is at a maximum. If the armature conductors are directly under the pole pieces when the motor current is maximum, then torque production is most favorable,




FIGS. 17 TO 23. SHOW THE DIFFERENT TYPES OF ROTARY CONVERTERS AND THE ANGULAR POSITION OF THE ARMATURE DUE TO CHANGE IN FIELD DENSITY

as in Fig. 21. Here the current in the conductors under each polepiece is in the same direction, and the maximum poles of the armature occur between the main poles and therefore will have a minimum effect upon them.

If the fields of a direct-current motor are weakened, the armature current increases and the machine speeds up. When the fields of a rotary converter are weakened, it also has a tendency to increase in speed, but when it does, the armature is caused to take a position where the maximum field strength of its poles will occur at some position under the main poles, as in Fig. 22. It will be seen that the armature poles are of a polarity that will increase the strength of the main poles and offset the effect due to reducing the field current and maintain the flux of the main poles approximately constant.

On the other hand, if the field strength is increased above normal, the armature will have a tendency to slow down; when it does, the maximum poles will occur in a position similar to that shown in Fig. 23. The armature poles are now in a position to oppose the main poles and weaken them, thus neutralizing the effect of the increased field current; therefore, tending to maintain the field flux approximately constant. From the foregoing it will be seen that the flux of the main poles of a rotary converter is held about normal value. Any change in normal field current is offset by the armature taking a new angular position.

If the armature conductors are under an interpolar space when the motor current is maximum, the torque production will be less favorable. As part of the conductors are producing torque against the direction of rotation, this overcomes the effect of the increase in current in the armature, as evident in Figs. 22 and 23. Increasing the excitation of the field poles tends to increase their magnetism and thus enhance the torque. The armature then takes up a new angular position such that torque production is less favorable, as in Fig. 23, thus retaining the effective torque at the required value. This angular shift of the armature, however, changes the phase relations between alternating voltage impressed at the taps and counter-voltage generated by rotation under the field poles. In consequence of this change the previously mentioned wattless current flows, which tends to maintain a fixed magnetism.

If the alternating voltage in the armature reaches its maximum at the instant that tap coils are in the interpolar space under a brush, then the maximum-load current flows through the tap coils only. The alternating voltage in the armature may reach its maximum at an instant when the tap coils are in an intermediate position between brushes due to the angular shifting described. In such a case the maximum-load current flows through not only the tap coils, but also the adjacent coils between the tap coils and the nearest brush. This causes greater heating of these intermediate coils. The first-mentioned position corresponds to unity power-factor operation; other positions occur with operation at less than unity power factor. With these latter positions a wattless current is involved, thus increasing the total armature current, consequently the resistance losses, and running up the temperature. In actual operation the armature heating is as follows: With unity power factor the tap coils are warmest. When operating with a lagging power factor the tap coils and one or two coils behind them are the hottest. With operation with leading power factor the tap coils and one or two coils ahead of them are the hottest.

The great increase of armature resistance loss and heating with other than unity power-factor operation may be seen when it is stated that the loss in the tap coils of a six-phase converter is about 50 per cent. greater at 97.5 per cent. than at 100 per cent. power factor, and 80 per cent. greater at 95 per cent. than at 100 per cent. power factor. The average armature-resistance loss at full load 85 per cent. power factor, is the same as at 150 per cent, load 100 per cent. power factor. It will thus be seen how important it is that the power factor should be maintained very close to unity with full load and overload operation.

# Visits of Inspector Brown--XIX

By J. E. Terman

*SYNOPSIS—Brown and an engineer have an argument regarding the flow of steam through an orifice. Brown quotes Napier's formula, and the engineer produces a table on steam flow stating as he did so that Brown did not know what he was talking about. Brown puts the question up to the Chief, who shows that both were wrong.*

As the Chief and Brown were on their way to inspect a plant a short distance from the city and had boarded the train, the Chief being comfortably seated reading the morning paper and smoking his pipe, Brown said: "Say, Chief, if you are not too much interested in the news this morning, I wish you would give me a little more information on the discharge of steam through an orifice. I thought that I knew all about this subject until I went to make the inspections at the Great Northern Lumber Co.'s plant. You know it is necessary to stay up there three days to get all the boilers, although the lot could be inspected in one day if they would give us all of them at one time. There is always plenty of spare time during those three days for a fellow to think over most everything that he ever knew, and as we had discussed nothing but safety-valve capacities recently, I was naturally thinking about that subject during my stay at the mill.

"The last day I was there, I got into an argument with the engineer as to the amount of steam that would flow through an orifice in a given time, and there is something I do not understand about the problem. I want to be thoroughly posted on the subject, for I have promised to show that engineer just where he was off the next time I came to the mill, and I want to put it over right.

"The way the argument started was, we were discussing the amount of steam that was probably used in the dry-kilns. The plant is getting short on boiler

capacity, and I told the engineer that it must be possible for quite a quantity of steam to flow through the connection to the kilns. I also told him what I had recently learned about the flow of steam through an orifice, and I wrote out Napier's formula, $W = \frac{P \times A}{70}$. I also told him what a simple thing it was to see, after having it explained, that increasing the pressure would increase the velocity and therefore increase the amount of steam that would flow through an orifice in a given time, and that the increase in flow would be in the same proportion as the increase in pressure.

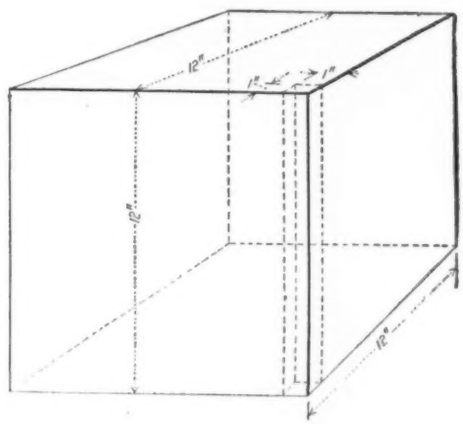
"Well, Chief, that engineer said that he did not know a thing about Napier's formula, but that if it showed that an increase in pressure increased the velocity of the steam flowing through an orifice, Napier did not know what he was talking about. We certainly had some argument, and finally the engineer said that he could prove that what I was telling him was all 'moonshine,' and he went to his desk and brought out a book on the steam engine. He turned to a table that gave the outflow of steam from a given initial pressure to various lower external pressures, and this table showed that the rate of flow was increased as the outside pressure diminished until this outer pressure was 58 per cent. of the internal pressure and then the flow was constant for all lower external pressures. A footnote to this table stated that the absolute pressures were referred to. The engineer said that this table proved that I did not know a thing about the subject, for he showed me that as the atmospheric pressure was 14.7 lb. an absolute pressure of $\frac{14.7}{0.58} = 25.34$ lb., or $25.34 - 14.7 = 10.64$ lb. gage pressure or more would cause the flow of steam through an orifice in the atmosphere to be at a velocity that is constant.

### Table Apparently Contradicts Napier's Formula

"I told him that I did not see how he made that out from his own table, for I pointed out that a constant internal pressure was used in the table and that the external pressure was varied, while he proposed to make the external pressure of 14.7 lb. constant and vary the internal pressure. The engineer said that it would be a poor rule that would not work both ways, and that he knew he was right. Well, he had me going, and I did not know how to show him that he was wrong, but I thought of the table in the Code for safety-valve capacities, and I showed him that a 3-in. valve with a bevel seat and a high lift would discharge 977 lb. of steam in an hour, if the pressure was 15 lb. gage, and that at a pressure of 100 lb. gage, the discharge from the same valve would be 3,774 lb. in the same time. I tried to impress on him the fact that the area through which the steam was flowing in each case was the same, and that therefore the velocity of the steam must be increased in order to discharge so much more steam at the higher pressure. There we were in a deadlock, each of us confident that he was right and with no one to whom we could submit the question to determine really who was right.

"Now Napier's formula must be right, and if I have retained any of the knowledge you have imparted to me about formulas, I am certain that Napier's formula indicates that if the pressure is doubled the amount of steam discharged is doubled, the same as if the area of the orifice was doubled, and yet I feel that that table in the book on the steam engine must also be nearly right, and I want you to tell me where the kink is so that I can put it over that engineer good and hard next time I see him."

"Well, Brown," said the Chief, "I am glad to help you to understand this question, but you will have to promise that you will write to that engineer and thank him for putting you on the right track in this matter, for while you were both wrong in your conclusions, the engineer was much nearer the facts than you were. It is a fact that with a fixed internal pressure and decreasing external pressures, after a point is reached where the $\frac{\text{outside pressure}}{\text{inside pressure}} = 0.58$ or less, the velocity of the outflow is constant. The engineer's contention that reversing the problem—that is, with a constant outside pressure and increasing internal pressures—the velocity of the outflow would be constant, where the ratio between the outside pressure and the inside pressure was not greater than 0.58, was not exactly true, but it was not out much.




CUBE AND SECTION 1-IN. SQUARE

Your contention that the velocity of the outflow increased directly with the pressure was away off, Brown, and I am not surprised that the engineer thought that you knew nothing about the subject.

"The main thing that you did not remember," continued the Chief, "was that Napier's formula gives the weight of steam discharged per second in pounds, and that a cubic foot of steam at 50-lb. pressure weighs very much less than the same amount of steam at 100 lb. pressure."

"Why, Chief, I knew that all the time," exclaimed Brown. "I don't know what made me so stupid. I can see now that that is where the whole difficulty comes in."

"Well, Brown, you may know all about this question now, but if we work out a problem you will be more certain whether you understand it or not. Where the outside pressure is 58 per cent. or less of the inside pressure, as it is for gage pressure of 11 lb. or more where the discharge is into the atmosphere, a formula giving the velocity of flow through an orifice is, velocity $= 3.5953\sqrt{h}$, in which $h$ is the height of a column of steam the weight of which would equal the absolute internal pressure. Now if a cubic foot of steam were to be divided up into sections one inch square and a foot

long, thus (see illustration), there would be 144 such sections.

"We can readily see from our steam table, that at 115 lb. absolute pressure a cubic foot of steam weighs 0.2577 lb., therefore a column 144 ft. high by one inch square would weigh 0.2577 lb., and to find the height of a column weighing 115 lb., we would have $144 \times \frac{115}{0.2577} = 64{,}260.72$ ft. Extracting the square root of the quantity just found gives 253.1, and $253.1 \times 3.5953 = 909.97$ ft. per sec. This, Brown, is the velocity at which steam would flow through an orifice from an absolute pressure of 115 lb. per sq.in. into the atmosphere or into another pressure of not more than $0.58 \times 115 = 66.7$ lb.

"Since the rate of discharge is, say 910 ft. per sec., there would flow through an orifice of one square inch area, $\frac{910}{144}$, or 6.37 cu.ft. of steam in one second; and since the weight of a cubic foot is 0.2577 lb., the weight of steam that would flow through such an orifice would be $6.31 \times 0.2577 = 1.62$ lb. per sec.

"Now let's check this up, by Napier's formula, $W = \frac{A \times P}{70}$. $A$ would be 1, since we have assumed that the area of outlet would be one square inch, and $P$ will be 115, the absolute pressure considered; then the weight of steam discharged per second would be $\frac{1 \times 115}{70} = 1.64$ lb. which you will see checks almost exactly with the amount determined by the method we just used. I want you to understand," continued the Chief, "that Napier's formula does not check up so closely in every case, for with lower internal pressures it gives slightly less weight discharged than as determined by the velocity of the flow through the orifice, and for higher pressures it gives slightly more, but at 215 lb. absolute pressure the difference is not more than 1½ per cent., so you can see that the formula may be considered accurate for all practical purposes.

"I told you, Brown, that the engineer's statement, that with a fixed outside pressure and varying internal pressures the velocity of outflow was constant, was not strictly correct. If you will figure out the velocity of outflow by the formula I gave you for 215 lb. absolute pressure, you will find that it is about 919 ft. per sec., and since at 115 lb. it is 910 ft. per sec., you will see that his statement that the velocity was constant was not so far out of the way."

### Steam Velocity to Atmosphere Little Over 900 Ft. Per Sec.

"Well, Chief, it will be an easy thing to remember; that is, that the velocity of flow from all ordinary boiler pressures into the atmosphere is a little more than 900 ft. per sec., and by making up a table of the effective discharge areas for the usual safety-valve sizes and the weight of steam per cubic foot for the usual boiler pressures, I can come close to the sizes of safety valves required under the Code rules, even if I haven't the Code table to refer to.

"I certainly am mighty glad, Chief, that you happened to speak about thanking that engineer for putting me right on this question. I will write him a letter tonight that should make him my friend for life, and I will bet that those boilers will be cooler and cleaner for me to inspect the next time I go there."

Just then the whistle sounded for the station at which the Chief and Brown got off, and the conversation was cut short.

# Operation of Low-Compression Type Oil Engines

By L. H. Morrison

*SYNOPSIS—Engines of the hot-bulb two-stroke-cycle type are considered with respect to some of the troubles that may arise, such as excessive vibration, wear on cylinder, cracked bulbs, pre-ignition and insufficient bearing lubrication. The author shows how most of these may be avoided by proper inspection and attention to details.*

In contradiction to the expectations of the average purchaser of the low-compression type of oil engine, it must be conceded that there are such things as operating troubles. Probably the first and most evident shortcoming of the ordinary installation of this type is the lack of sufficient foundation. Some oil-engine builders do not indulge in the habit of the steam-engine manufacturer of having an ample foundation plan. It is possible to reduce the average steam-engine footing plan as much as 30 per cent. from that shown on manufacturers' blueprints and still have ample foundation; on the other hand, it is usually advisable to increase the oil-engine foundation about 25 per cent. above that recommended by the manufacturer. This may seem rather a strong statement, but the writer's observation of a great number of plants bears out the claim.

The result of a scanty footing is vibration of the engine with accompanying hot boxes, leaky piping and an occasional fractured engine frame. In a number of instances the operator has been compelled to trench around and under the concrete footing in order to bring the foundation up to the proper amount. It is a good idea to be generous with the foundation, and in case it allows the engine to vibrate, set to work immediately to remedy it by additional concrete before there is much opportunity for damage to be done such as enumerated above.

Some of these engines of the two-stroke-cycle type employ crank-case compression, wherein the air necessary to scavenge the cylinder of the burnt gases is compressed in the inclosed crank case. This design makes a very compact engine and lessens the manufacturing cost. However, it has drawbacks that cannot be ignored, for the

crank case being inclosed prevents easy inspection of the connecting-rod bearings. The operator should make a weekly inspection of the crank case, removing the cover plates, examining the rod bearings and draining all oil from the case. The latter should not be neglected, for if any great amount of oil is left in the crank case, it will splash into the cylinder at each revolution. This oil will carbonize on the cylinder walls and on the piston rings, causing wear and loss of compression. Furthermore, it will tend to cause the exhaust to be decidedly smoky as well as to increase the fuel consumption.

Another trouble due to this manner of compression is the tendency for this air to leak out through the shaft bearings, blowing the oil from that part of the bearing nearest to the crank case. Some engines are equipped with an air-seal ring to avoid this trouble, this ring generally being a flexible brass plate placed on the shaft and allowed to press against the bearing face, thus preventing air leakage. This is a good design, but the operator should keep an extra set of rings on hand so that he can replace them at the first sign of leakage; if this is neglected, a hot bearing will probably result.

In engines using a stuffing-box arrangement on the outer end of the shaft bearing, care should be taken to keep the bearing absolutely air-tight. If the upper half is removed for inspection, the operator should clean the flanges carefully, using a thin paper for a shim or gasket so that on replacement the bearing will retain its air-tightness.

### Care of Cylinder and Piston

Special emphasis should be laid upon the care of the cylinder and piston. The causes contributing to the wearing of these parts are numerous. Those most encountered are lack of lubrication and deposits in the water jacket. The former calls for but little comment; it is self-evident that sufficient lubrication must be supplied. However, the oil used should be chosen with care. Moreover, too much oil is about as bad as too little, in that excessive carbonization will occur, resulting in gummed rings and scored cylinder. Gummed piston rings usually can be loosened by the use of kerosene; in case this fails, immersion in strong lye will remove all the carbon and tarry matter.

As regards deposits in the cylinder jacket, the amount of the deposit will vary with the kind of cooling water and the temperature carried. If it is possible to secure enough rain water, this should be done; using a cistern and cooling tower or screen will keep the temperature down to normal. If the water carries a large percentage of lime and mineral matter, the operator should examine the jacket frequently. The use of a small quantity of graphite daily will keep the jacket fairly clean. Often the suggestion is made to use a cistern or cooling tower where the water is bad, with the expectation that the minerals will settle in the tank. This the writer believes to be bad practice because the temperature in the cistern is never high enough to allow precipitation of the solids, and since probably 10 per cent. of the cooling water evaporates in the process of cooling, the result is that the remaining water contains an ever-increasing percentage of objectionable matter. When compelled to use bad water, it is best to let it go to waste.

It is well to remind the operator that, on shutting down, the cooling water should be allowed to circulate through the jacket for some time after the engine is at rest. The piston contains a great amount of heat, and on stopping, if there is no circulation in the jacket, this heat has a tendency to cause the piston pin to increase in length. This distorts the sides of the piston, "freezing" it to the cylinder walls; consequently when ready to start again, the operator finds it impossible to pinch the engine off center. Another result is the seizing of the piston-pin bearing.

### Reason for Water Injection

A great many low-compression oil engines use some method of water injection, whereby at each cycle a small amount of water is injected into the cylinder. Many claims have been made as to the increased economy due to the use of water, some contending that, in the presence of such intense heat, it separates into its component parts, hydrogen and oxygen, which unite with the gases of the fuel. The real reason for water injection is to keep down preignition. Because of this, an engine of given cylinder dimensions will show a greater power than without water injection, since a greater amount of fuel can be injected without danger of preignition. It has its disadvantages, however.

When using Southern oil, there is a tendency toward rapid cylinder wear. This is probably due to the formation of sulphuric-acid gas by the union of the water and the sulphur content of the oil. It has been claimed that the oxygen acted directly upon the cylinder walls, forming iron oxide which cut the cylinder and piston. However, with Eastern and Mid-Continental oil, low in sulphur, there appears to be no cutting, so the former explanation is probably correct.

In operation, when the load is light, the engine tends to miss a few explosions, owing to the cooling effect of the water. The usual remedy is to cut down the amount of water. But in case the load is a varying one, it is better to miss a few explosions on the low loads than to reduce the amount of injection water and on heavy loads experience preignition with a chance of a cracked head or crank case. Some engines have automatic regulation of the injection water, whereby the amount of water is varied in proportion to the load the engine is carrying.

### Broken Hot-Bulbs

Many engineers are in constant fear of a broken hot-bulb or cylinder head. There is little danger if the bulb breaks, and it takes only a short time to replace it. This is one of the minor troubles that need cause the engineer but little worry. As regards the breaking of water-cooled heads, this is due almost entirely to lime deposits, and attention to this detail will remove all danger. A duplicate cylinder head as well as a duplicate hot-bulb should be carried in stock.

When using kersosene or high-gravity distillate, there should be no trouble with the injection nozzle, provided the engine is fairly well loaded. In cases where the engine is of much larger size than the load requirements, there is occasionally trouble due to the end of the nozzle becoming caked with carbonized oil. When using heavy-gravity oil, especially fuel oil, the nozzle may show a tendency to become clogged with a tarry-like substance, regardless of the load carried. In order to remove this trouble, which will reveal itself by the engine showing poor regulation and missed explosions, it is necessary to

clean the nozzle. This can be done by soaking it in strong lye for a few hours.

As regards the fuel-injection pump, this part of the engine usually needs little attention to keep it operating properly further than an occasional cleaning of its valves to prevent sticking.

With many designs of the two-stroke-cycle engine, there is more or less bearing trouble. In this engine, especially when of the vertical type, the bearing pressure is always in one direction, so that it is hard to maintain an oil film on the shaft. If ring oilers are used, the lower half of the bearing should be slightly beveled at the parting so that the oil film will not be broken as the shaft passes this point. When the bearing is supplied by a force-pump feed, care must taken to see that the piping is clean and unobstructed.

Another precaution that the engineer should take is maintaining the exhaust pipe and exhaust pit in a fairly clean condition. With the two-stroke-cycle engine there frequently are particles of the fuel that fail to burn in the cylinder; these settle in the pipe and pit. After a certain amount has accumulated, it is likely to be ignited by the hot exhaust flame, causing a terrific heat and oftentimes an explosion. To this have been traced several fires that destroyed entire plants.

The final word of precaution should be addressed to the plant owner. By all means employ as engineer a man who is a mechanic. It is not necessary that he be a steam engineer, but he should know the value of good machinery, be able to learn the peculiarities of the oil engine and to make ordinary repairs. Given good treatment, this type of engine will give returns on every dollar invested in it.

## Climax Smoke Preventer

A device designed for the prevention of smoke, using the steam jet for supplying the required amount of air to the furnace, is the Climax smoke preventer, manufactured by the Climax Smoke Preventer Co., Boston, Mass. No new principle is claimed, but a number of improvements have been made over the older design.

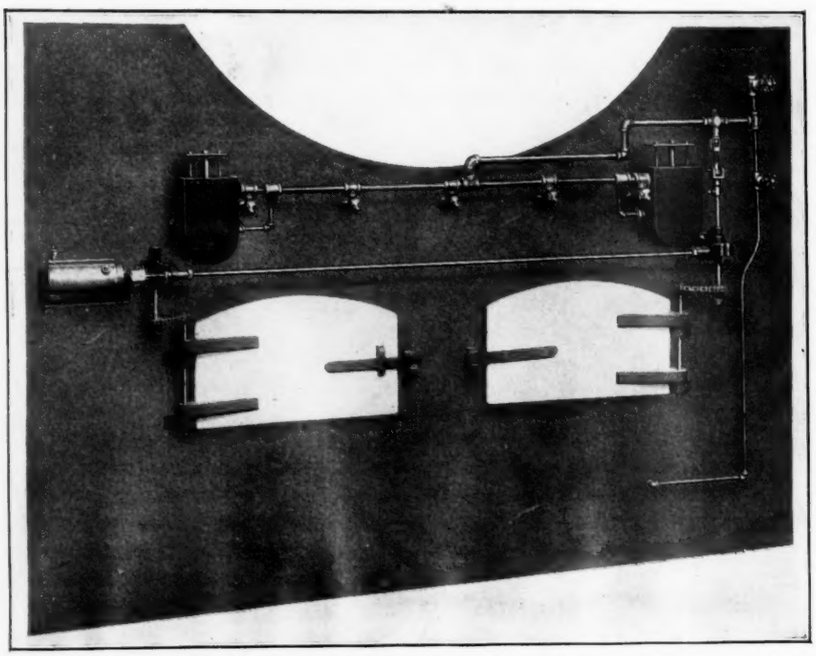


FIG. 1. SMOKE PREVENTER IN POSITION ON BOILER FRONT

The mechanism is operated by the opening and closing of the furnace doors. When a door is opened, it opens a steam valve and steam is admitted to jets and to air-

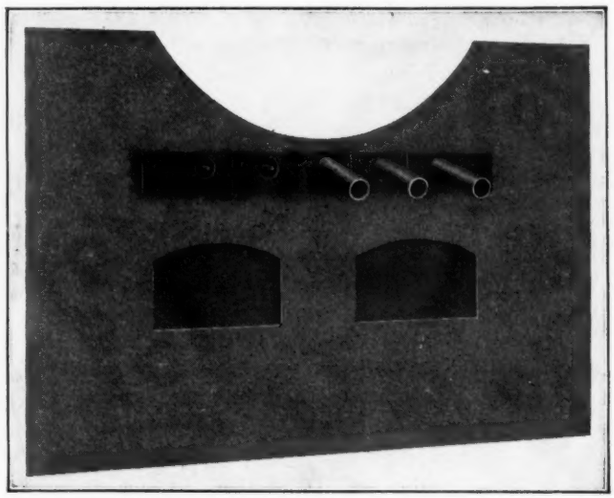


FIG. 2. COMBUSTION TUBES AND BOXES READY TO BE BRICKED IN

damper boxes, the pressure opening the dampers. Air and steam are then blown into the furnace through nozzles set in the furnace brickwork at the front of the boiler setting, until the steam is automatically shut off, also the air supply, by the closing of the furnace door; there being a time element between the closing of the door and the shutting off the steam. Both steam and air valves remain closed until a furnace door is again opened. It makes no difference how long the door remains open, the automatic cutoff does not begin to close the steam valve until the furnace door has been closed. Admitting steam and air to the furnace during and directly after the firing period prevents the formation of smoke. The period of admission is from 3 to 5 min. after each firing, but this can be varied to suit the quality of the coal. This apparatus consists of several members. The damper of each damper box, shown at either side in Fig. 1, while opened by steam pressure is closed by its own weight when the steam is shut off. This box connects with an air duct that is bricked into the front arch of the boiler setting. The duct is composed of several sections, according to the width of the furnace, each section containing one or two steam-jet nozzles that are connected to the main steam supply. Fig. 2 shows the air box and nozzles ready for bricking in. The piping between the air boxes and the steam nozzles is shown in Fig. 1. At the right of Fig. 3 is shown a quick closing and opening balanced valve, the arrangement for its operation being illustrated. A yoke is screwed to the valve body, and the lower part is drilled and

tapped for a special thread and an auxiliary stem operating in it. A half-turn of this auxiliary stem opens the valve full.

When either furnace door is opened, a lug on a loose sprocket wheel engages a lug on a fixed collar, which opens the steam valve and causes a rack rod to slide from left to right moving a piston in a cylinder. The furnace door is closed without affecting the apparatus, except to release the automatic closing device for shutting off the steam supply to the steam jets. At the left of Fig. 3 is shown the automatic closing device. It consists of a cylinder and piston, the latter having a check valve on one end and a piston rod at the other. At one end of the cylinder is a needle valve that connects with a bypass to the other end. A coil spring is placed between the piston and the cylinder head. The piston rod is connected to either a right or a left rack rod. One chamber of the cylinder is filled with oil or glycerin. When either furnace door is opened, the rod operating the mechanism moves from left to right and pulls the piston to the end of the cylinder, compressing a coiled spring. The oil that has been in that end of the cylinder rushes through the piston check valve. When the furnace door is closed, the spring starts the piston toward the other end of the cylinder at a speed that is governed by the needle valve past which the oil is being forced and through the bypass back to the other end of the cylinder. The movement of the piston actuates the mechanism that closes off the steam and air. As the needle valve can be adjusted for a long or a short period of piston movement, the time limit for the operation of the steam jets can be governed to suit the kind of fuel being burned, and thus giving the system a considerable degree of flexibility.

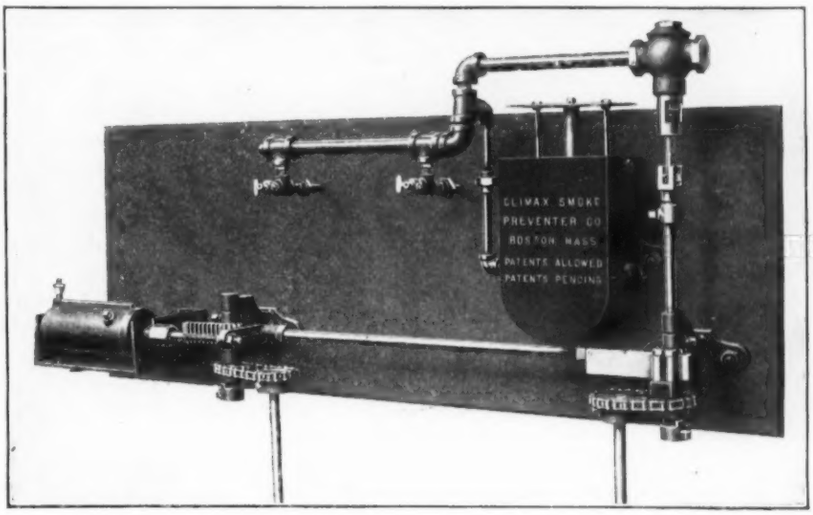



FIG. 3. SHOWING AUTOMATIC MECHANISM.

# Review of Some Ammonia Explosions

By Charles H. Bromley

*SYNOPSIS—Analyses of some of the most serious explosions of ammonia refrigerating apparatus are given, as well as some suggestions on safety in refrigeration plants.*

For two reasons chiefly—because of the rapid development of the refrigeration art and because of the number of serious explosions of refrigerating apparatus—critical studies of the causes of such explosions are essential to the healthy growth of the industry. The number and kind of explosions are not alarming, and in that there is optimism for user, manufacturer and engineer. But there must be a more general recognition that, first, any high-pressure ammonia plant, like any boiler plant, is pregnant with potential danger; second, that ammonia in a refrigeration system may become a powerful explosive; third, that the employment of untrained men to care for such apparatus may properly be regarded as criminal. This last brings up the question of what should be the capacity below which an ammonia refrigeration system may be allowed to operate without a licensed man in charge, considering now states or cities having license laws; which question is taken up in later paragraphs.

The explosibility of gases generated in a refrigeration system has been well established and analyzed in recent technical literature by Prof. R. Plank[1] and F. L. Fairbanks,[2] and only the "high spots" of their investigations need be mentioned here. Professor Plank has shown that reactions bringing about decomposition of ammonia are rapid at temperatures prevailing in practice; he has shown that catalytic action in the compressor cylinder and discharge pipe is responsible for decomposition. The mechanical impact of sudden compression is an influence that is difficult to calculate but which is known to exist.

Mr. Fairbanks has been unable to produce explosion of refrigeration-system gases by detonation, but has shown that the lubricating oil at operating temperatures becomes a hydrocarbon gas which, when subject to ignition, is highly inflammable when mixed with certain proportions of air and highly explosive when mixed with certain other proportions. Actual explosions corroborate this statement. Mr. Fairbanks' experience has also shown that when zinc or zinc alloys are in contact with ammonia at high temperatures, decomposition is accelerated and considerable hydrogen liberated. All experience shows that for an explosion of apparatus containing ammonia—

[1] "Power," Dec. 28, 1915, pp. 914, 915 and 916. Originally published in the "Zeitschrift für die gesammte Kalte-Industrie," Berlin.

[2] "Power," Nov. 23, 1915, pp. 715, 716 and 717.

or more correctly, the ammonia itself under operating conditions—there must first be a break liberating to the atmosphere the already-present gases of decomposition and the ammonia, and second an arc or flame to ignite these gases, which quickly unite with the oxygen of the air to form an explosive mixture. It is probable that after the explosion has started, decomposition occurs

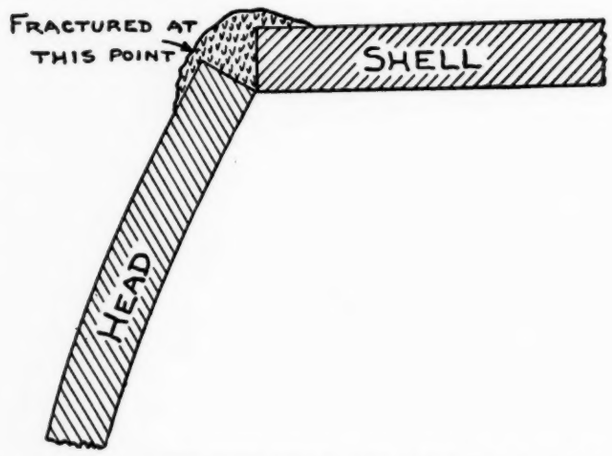



FIG. 1. SHOWING HOW HEAD WAS WELDED TO SHELL

rapidly enough in the intense heat to keep up the supply of the explosive until it burns itself out. That high operating temperatures without the effect of impact will produce decomposition is shown by the fact that the gases issuing from the purge pipe of an absorption system may be ignited almost any time.

To return to the question of how small a refrigeration plant should be to be safely operated by an unlicensed, and therefore assumably an untrained man, one remembers that some very serious explosions have occurred to small, and in some cases supposedly automatic, apparatus. One of the most recent of these, which happened at Brooklyn, N. Y., is fresh in the mind. This explosion wrecked the entire building.

At the last public hearing on this question before the Massachusetts Board of Boiler Rules there was heated discussion, some manufacturers claiming that it meant ruin to them if a law requiring licensed men in attendance of small machines were passed. The machine in Brooklyn which exploded recently was of the gas-heated generator type wherein the one vessel acts as generator and absorber. It was supposed to be automatic or so nearly so as not to require skilled attendance. The explosion wrecked the building, killed five persons including the owner of the machine and injured twenty. The chief of the Fire Department Bureau in charge stated that the seriousness of the explosion made imperative the thorough consideration of the question of licensing operators of all such machinery, regardless of capacity. It will be remembered that the Brooklyn machine was not over two tons capacity.

On the afternoon of Sept. 14 the receiver tank of a twenty-ton refrigerating plant belonging to the Interstate Milk and Cream Co., of Newark, N. J., exploded, instantly killing six men, including the president and secretary of the company, a seventh later succumbing to injuries, and seriously injuring four others. The plant was a new one on which the final tests were being made preparatory to turning it over to the owners. Without much of a report and doing comparatively little damage to the building, the receiver opened its entire length.

The receiver had been tested to 300 lb. air pressure, and about three weeks prior to the accident a preliminary test had been run on the plant, at which time everything was found to be working satisfactorily. The normal working pressure of this system is 125 lb.

The plant was in charge of the supervising engineer, who was killed by the explosion. Details as to what happened just previous to the accident are very meager, but from what can be obtained from those who survived it is understood that the condensing water failed, owing to a fuse blowing on the circulating-pump motor. The dairy company's engineer went into the basement to replace the fuse, but before he had time to return the explosion occurred. It is supposed that the accident was caused by leaving the compressor running when the circulating water failed on the condenser. The gas not being condensed, the compressor increased the pressure to the point where something had to give way, there being no safety valves; and as the receiver was the weakest point, it ruptured. When the rupture occurred, the reduced pressure caused whatever liquid ammonia there may have been in the system to be immediately converted into gas with a consequent explosion.

The receiver was 20 in. diameter and 10 ft. long, with a $\frac{7}{16}$-in. shell, the seams autogenous-welded. From all appearances, the longitudinal seam failed about midway between the headers, and starting at this point, it opened the entire length. One header seam opened for about three-quarters of the circumference, the other two-thirds of the circumference.

From an examination of the break it is obvious that whatever else may have been contributory to the explosion, part of the welding was defective. For about half the length of the longitudinal seam the weld had the appearance of being well made, but in the other half the metal did not seem to have been melted for more than about one-half the thickness of the shell. The indications are that the shell first gave way near the beginning of the defective welding.

There is probably no doubt that the plant was constructed according to general practice in vogue at present. However, the explosion shows that a refrigeration system is just as dangerous or more so than a steam boiler when not properly handled, and therefore should be equipped with the proper safety devices. It is believed that further investigation will show that safety valves are a necessary part of a refrigerating plant and that this accident could have been prevented if they had been installed.

This accident recalls that at Vogelsang's restaurant, Chicago, where the welded head of an ammonia generator ruptured at the weld, killing one man and seriously injuring four. Like the Newark generator, explosion occurred before the makers had turned over the apparatus to the purchaser. The following is from the *Locomotive* for October, 1915:

> The tank, which was 8 ft. long and 2 ft. diameter, was built of ½-in. plate, both for the heads and shell. The heads were bumped, cut to size with an oxygen torch and joined to the shell with a welded joint which came exactly where the flange turn would be located in a riveted tank. Fig. 1 will make this clear. We are told that a pressure of 154 lb. per sq.in. could be put on the vessel in the regular course of its operation, but that the pressure at the time of the accident was about 100 lb. Failure occurred at the joint between the

head and the shell, but a brick pier adjacent to the head received the brunt of the explosion and prevented the complete rupture of the seam, the head remaining partly attached to the shell, as is shown in Figs. 3 and 4. Fig. 2 shows the edge of the head after the accident. It will be observed that the edges show two distinct characteristics—a narrow, rough and somewhat torn portion and a wider serrated portion with grooves parallel to each other but at right angles to the surface of the plate. The narrow, rougher portion represents the part of the sheet to which the metal added in the process of welding had become actually attached. The grooved portion shows the characteristic appearance of metal cut by the oxygen cutting torch and had never been incorporated in the weld at all. The incorporation along the edge of the shell plate seems to have been better, as the weld was not torn away from that plate at all. It has been suggested that failure to chip off or otherwise remove the oxidized surface left on the edge of the head after cutting with the torch is the reason for the lack of bond between the added metal and the head. It seems more likely to us that too great haste on the part of the operator, who appears not to have let his weld clear itself of impurities or to have heated the edges of the head hot enough for them to actually melt together with the added metal, is more likely to have been the real cause of the trouble, though as we are not practical welders, we must offer this merely as a suggestion. The points we particularly wish to emphasize are not so much the defects in the welding itself as the errors in design and the wisdom of employing a welded joint at all for this particular service.

It is well known that all bumped heads on vessels subjected to internal pressure breathe with changes in that pressure. This is because of the presence of stresses tending to change the form of the head to a hemisphere of radius equal to that of the shell. The greatest deforming tendency, and therefore the greatest movement comes at the point where the spherical head joins the cylindrical shell, and this tendency can be shown to be a maximum where this change is abrupt, as in the tank in question. If a flange is turned on the head, it eases the change in curvature, making the stress distribution more uniform in that it spreads the bending stresses over a greater portion of the material and hence reduces the stress at any particular section. This reasoning is true, regardless of the method employed to join the head to the shell, and has given rise in many instances to minimum radii being specified for the flanges used on given sizes of heads. In a welded tank there is a twofold weakness if the construction used in the exploded vessel is followed: First, the form is inherently weak as we have just pointed out, and secondly, the metal which receives the maximum bending action is the added metal of the weld itself.

[In reply to an inquiry by the author as to the significance of "minimum" as here used, H. J. Vander Eb of the Hartford Steam Boiler Inspection and Insurance Co., publishers of *Locomotive*, replied that, "The word 'minimum' was not intended to convey the idea 'as small as possible,' as you apparently thought, but it was used to state 'not smaller than a certain dimension.'" This dimension of radius to be ample to form a sufficiently gradual flange turn to take up breathing action.—Editor.]

Here it is interesting to recall comparatively recent discussion on the form (flange fillet radius) of, and on the factor of safety for, convex heads for cylindrical pressure vessels. Failure of convex heads is nearly always at the "heel" of the flange, or where the head diverges from the spherical form to assume the cylindrical form, for naturally the head under pressure tends to shape itself to the same radius as that of the shell, causing greatest flexure at the "heel," the stress being less localized the greater the radius of the flange.

The gist of this discussion by able men[3] is that the radius of the fillet should be at least five times the thickness of the plate, as Mr. Vander Eb suggests, or a flange of considerably increased thickness—above the thickness of the head and shell—should be used to join the head and shell, as Mr. Gasche proposed.

The fact that any builder would use a joint such as that shown in Fig. 1 on a vessel in which there was any possibility of dangerously high pressure is evidence that the knowledge of stresses in convex heads and of the uncertainty of autogenous welds, is not as widely applied as it should be, notwithstanding that this may be an isolated case. The experience with large welds in ammonia pressure vessels has so far been most disappointing and, it seems, will continue to be so until the skill of the welder becomes so generally good as to go unquestioned, and provisions are made to allow the stresses consequent to welding to flow in order to secure their best possible distribution.

The Bureau of Surveys, New York Board of Fire Underwriters, in a report on several ammonia plant explosions gives the following:

By way of accounting for explosions of ammonia vapor suddenly released from high pressure, when not attributable to the presence of lubricating oil, it has been suggested that decomposition of the ammonia might take place, especially in the presence of an intense heat such as that of an electric arc light, resulting in the liberation of hydrogen, which forms an explosive mixture with air. It has also been suggested that certain impurities in the ammonia might increase the tendency to decomposition or explosion. In a number of the

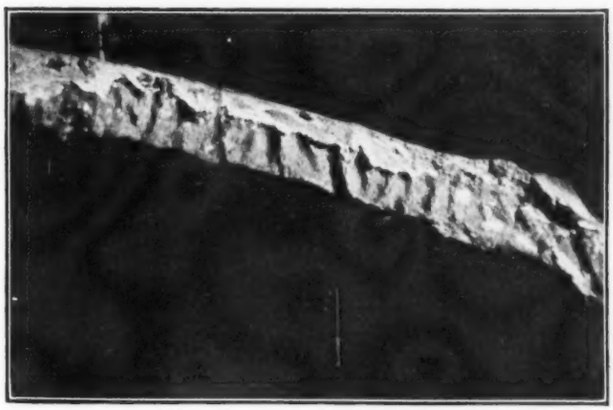


FIG. 2. END VIEW OF RUPTURED HEAD

cases reported herein a definite explanation of just what caused the explosion of the ammonia vapor seems to be impossible, but the facts as nearly as can be ascertained are submitted.

The practice of testing refrigerating systems with air pressure is especially hazardous, unless all oil is thoroughly removed from the entire system and great care is taken to prevent overheating of the air while being compressed. The last explosion herein reported was due to this cause.

Manhattan Refrigerating Co., Horatio and West St., New York City, accident of Apr. 26, 1915: The refrigerating plant is located on the first floor, and parts of the refrigerating machinery extend to the second and third floors. Parts of the second and third floors were also used as pipe-fitting and repair shops, with an open coal forge on the third. The fourth, fifth and sixth floors were used for cold-storage rooms. The boiler plant was in the basement.

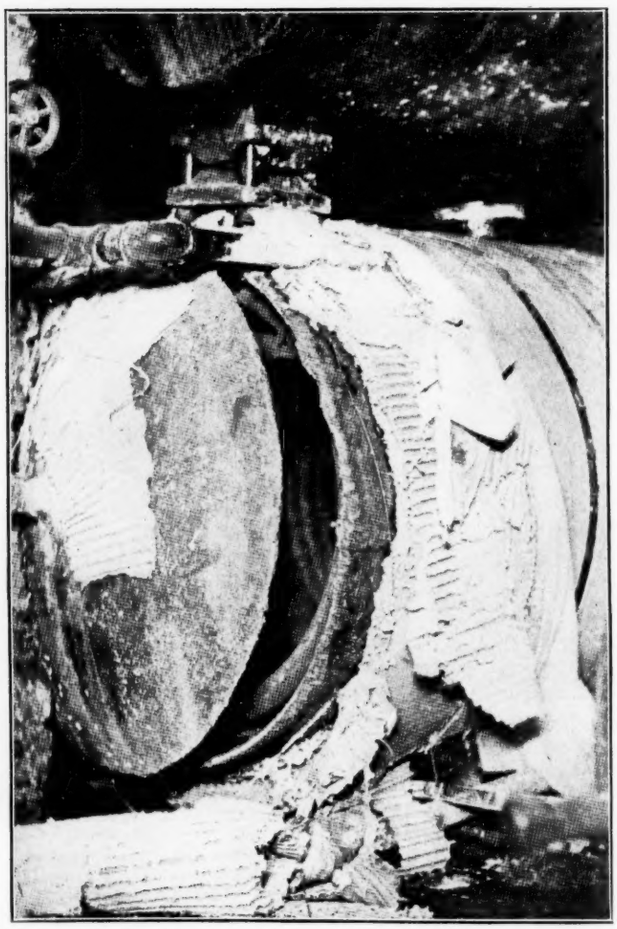
About 1 p.m. a noise described as "a puff," emanating from the second floor, was heard by the engineer and other employees. The trouble was caused by the breakage in a pipe connection on the second floor between the analyzer and the rectifier of an absorption-type refrigerating system. Immediately after, a considerable number of glass windows in the front wall of the building were blown out. According to information received, a mild explosion occurred about five minutes after the first explosion. The ammonia gas had spread rapidly and reached the open coal forge on the third floor, which may have caused this explosion. Apparently the rush of gas scattered the embers of the forge, which resulted in a fire in workmen's coats hanging near-by.

It seems difficult to account for the mild explosion alleged to have occurred about five minutes after the accident. One

[3]Convex Boiler Heads, by H. J. Vander Eb, "Power," Jan. 13, 1914. Spheres and Convex Heads, by T. T. Parker, "Power," Jan. 13, 1914. Stresses in Convex Heads, by F. G. Gasche, "Power," July 7, 1914. Stresses in Convex Heads, by H. J. Vander Eb, "Power," Dec. 8, 1914. Convex and Concave Drum Heads, by D. Hogan, "Power," Mar. 30, 1915.

theory advanced is that the fire in the forge exploded a mixture of ammonia gas containing various impurities; the explosion can hardly be attributed to oil in the ammonia, as this was an absorption system. It is supposed that the force of the explosion spread the embers from the forge and ignited the combustible material in the vicinity and that this fire caused the two automatic sprinkler heads to operate.

H. C. Bohack & Co., retail groceries and provisions, 102 Seventh Ave., Brooklyn, N. Y., accident of Apr. 23, 1915: The refrigerating machine was a 6-ton compressor driven by belt from a 15-hp. direct-current electric motor, and was used for cooling meat boxes, etc., by the direct expansion of ammonia through coils therein. The cylinder was cooled by water jacket around the cylinder head. Oil was used only for lubrication. The machine was not operated continuously, and it was the practice of one of the employees to take charge of the system. It was usually started every morning, an engineer being employed to give advice and occasionally special assistance when needed. At 10:30 a.m., after the



FG. 3. THE HEAD PARTIALLY BLOWN OFF

machine had been in operation about two hours, the cylinder head blew off, with a violent explosion, breaking near-by windows and blowing down a 4-in. tile partition adjoining the machine. There was no fire or evidence of any explosion resulting from the gas after it was liberated. The room was lighted by incandescent electric lights. The only possibility for any spark was at the commutator of the direct-current motor.

It is difficult to account for the blowing off of the cylinder head, other than as the result of some mechanical weakness or the presence of liquid ammonia or oil in the cylinder. It is claimed that there had been no testing of the system with air, which is a dangerous practice. This is one of the few cases where no fire or explosion seems to have resulted from the liberation of ammonia fumes, presumably mixed with lubricating oil. The lack of an open fire or spark may account for it.

Mayer Brewing Co., 3544-3562 Third Ave., New York City, accidents of Apr. 11 and 21, 1915: The refrigerating plant, which served a brewery, consisted of a 55-ton and a 110-ton compressor, each driven by a Corliss engine. Each compressor had an individual oil separator, but there was only one set of condenser coils, etc., so that only one machine could be operated at a time. The brewery was refrigerated by brine circulation. The cylinders of the compressors were cooled by the "freezing-back" method (utilizing the refrigerating effect in the returning ammonia).

There were two explosions within a few days of each other. The cylinder head of the 55-ton machine blew out at 7:25 a.m., Apr. 11, 1915, and the cylinder head of the larger machine blew out at 5:30 a.m., Apr. 21, a few hours after it had been started, both compressors having been out of operation during the time between the two explosions.

The two compressors apparently failed because of mechanical weakness in the materials of which the piston rod and follower were made.

The failure of the first machine was due to the breaking of the piston rod at the base of the thread at the nut which holds the piston on the rod. The fracture was without signs of flaw or crystallization. The dislodged nut was caught between the piston and the cylinder head on the return stroke and knocked out the head. Probably the vapor, consisting of ammonia and perhaps lubricating oil, filled the room and was ignited from open gas lights, and an explosion resulted, causing considerable damage to the building and machinery.

Repairs were completed in about nine days, and the system tested out to 300 lb. air pressure. After the test was completed, the air was thoroughly pumped out of the system, leaving a vacuum of about 25 in. of mercury. The ammonia was then replaced and the system put into operation, using the large compressor. About fifteen hours later a break occurred in this compressor; in this case, however, it was not the piston rod which broke, but the follower plate of the piston. The cylinder head was knocked out, and the escaping ammonia and oil was again ignited from the open gas lights, which had not been removed after the first explosion. The second explosion deranged the entire refrigerating plant and was followed by fire, which resulted in the destruction of practically all combustible parts of this building.

Both explosions were probably due to lubricating oil mixed with the ammonia gas when discharged into the refrigerating room. A number of theories have been advanced to account for the rupture of the reciprocating parts of the compressors. The usual stresses, together with the cooling and heating which occurs in every stroke of the piston, may have gradually weakened the piston. Because of overhauling the nut on the end of the piston may have been screwed up unduly tight; the expansion of the piston due to heating, in addition to the working loads, may have stressed the material beyond the elastic limit. The piston rods were lubricated by the usual oil seal, the oil being circulated by a small pump, the only lubrication of the cylinder being by the oil that escaped from this oil packing. It is possible that an excess of oil may have found its way into the crank end of the cylinder from this source and filled the clearance space with an incompressible liquid, which would account for the break.

Charles Weisbecker, groceries and provisions market, 267-269 West 124th St., New York City, accident of Aug. 31, 1914: The refrigerating plant consisted of two compressors, one of 40-ton and one of 25-ton capacity, supplying refrigeration by direct ammonia expansion system to the iceboxes in the basement and on the first and third floors. The compressors were chain-driven from 70- and 40-hp. direct-current electric motors. In these compressors oil is injected into the cylinders for the purpose of lubrication and cooling. Shortly after midnight, when the engineer was putting new oil into the system, the oil reservoir with glass sight openings connected to the piping broke and ammonia gas escaped into the room to such an extent as to drive out the engineer. The arrangement was such that practically all the oil in the system would be blown out. There was no evidence of any fire or explosion accompanying the bursting of the glass reservoir. There was no exposed fire or light other than the possibility of a spark at the commutators of the electric motors. No explosion appears to have resulted immediately from the liberation of the ammonia vapor, but there was evidence of fire having occurred later. The place was untenantable on account of the ammonia fumes for some time. When entered, the appearance of the compressor room indicated that a mild explosion or burning of the mixture of the ammonia gas and liberated oil had taken place at some time subsequent to the bursting of the gage-glass. The only spark to account for this ignition would be that from the commutators of the motors.

Jacob Ruppert Brewery, 205-207 East 92nd St., New York City, accident of June 28, 1912: The explosion in the refrigerating plant was caused by the breakage of four bypass

valves of the water-jacketed cylinders on a 280-ton refrigerating machine operating under 100 to 125 lb. steam and delivering ammonia to the receiver at about 180 lb. Oil was used only for lubrication.

It is stated that the machine was working normally at the time of the accident, in which case the bypass valves of the cylinders would be closed. (These bypasses are used to draw ammonia vapor from the discharge pipe into the suction pipe when emptying the compressor.)

The cause of the breakage is not easily accounted for, but it may have been due to a large influx of liquid ammonia from the suction side into the compressor, though this irregularity is generally recognized in refrigerating plants, especially in large installations supplying a number of lines, and can usually be adjusted without accident.

Three to five minutes elapsed between the breakage of these valves and the explosion, the latter being due to the ignition of vaporized oil in the escaping ammonia gas, or to the decomposition of the ammonia gas liberating hydrogen which would form an explosive mixture with the air.

It is possible that the uninclosed arc lights in the vicinity caused the decomposition of the ammonia; in any event, it would appear that the arcs ignited an explosive mixture, however formed.

Part of the electrical apparatus on the switchboard was somewhat damaged and badly discolored. Some material in different parts of the room in the line of the explosion was burned, notably burlap behind the switchboard and a coat hanging 7 ft. distant. The damage to machinery was comparatively slight. There was practically no damage to the structure except that some glass and other fragile material in this building and elsewhere in the vicinity were shattered by the explosion.

Schwartzchild & Sulzberger Co., First Ave. and 45th St., New York City, accident of March, 1901: This explosion occurred in an oil separator in the discharge line from a 200-ton ice machine. This separator was constructed of extra-heavy pipe, with cast-steel caps at the ends, with screw joints, soldered at the ends. It was 12 in. diameter and 6 ft. tall and was supported on a cast-iron stand. A draw-off valve was provided at the bottom for removing the oil.

Previous to the explosion the compressor had been overhauled. When this was completed, the engineer was instructed to clean the oil out of the separator. He claimed he did this, but the oil on the walls after the explosion seemed to indicate that it was not done, although this oil might have been blown out of the rest of the system. They then started to test the system with air pressure. The pressure had been built up to 250 lb., when the separator exploded with great violence, seriously injuring a number of employees.

There seems little doubt that the separator or the system contained a considerable amount of oil and that this oil in contact with air formed a combustible or explosive mixture, which was ignited by the overheated air discharged from the compressor. This danger is always imminent when air is compressed in such systems if any oil is present.

The following is from a letter to the writer from George E. Nye, chief inspector, Department for the Inspection of Steam Boilers, Steam and Cooling Plants, Chicago:

In late years Chicago has been very fortunate in regard to accidents in refrigerating plants. There are close to 800 units installed, and all plants have been subject to city inspection for the last eight years; during this period we have on our records three accidents with fatal results:

At the Western Packing and Provision Co. the cause of an accident was the breaking of the belt with the governor blocked; the result was the explosion of the flywheel, which wrecked the main liquid line, and the engineer was killed by the escaping ammonia fumes.

Another accident was at Armour's plan. about three years ago. Workmen repairing an atmospheric ammonia condenser did not take proper precaution to ascertain whether the sections were properly pumped out or under pressure. By removing all nuts of the flange bolts of a return bend, the fitting gave way, and as the condenser was still under pressure, two of the men were overcome by ammonia fumes and killed. Both these accidents could have been avoided if the men in charge had been more careful and attentive.

The last accident occurred at Vogelsang's restaurant. Here an ammonia generator exploded, killing one man. A correct and interesting report of this accident you will find in the October issue of the "Locomotive," published by the Hartford Boiler Insurance Co. [An abstract of this report appears in this article.—Editor]

This department is well aware of the fact that with the rapid development of artificial refrigeration in the many branches of industry, the mechanical press can render vital points of primary importance to the public in regard to the safety and proper installation of cooling plants for different purposes. By virtue of a city ordinance this department, from time to time, has adopted and enforced the installation of safety devices, and is prepared to render assistance and give advice to anyone contemplating the erecting of a cooling plant in the City of Chicago.

J. C. McCabe, inspector and engineer for the Department of Safety Engineering, Detroit, Mich., says of conditions in that city:

We do require that a responsible person be held for the safe operation of all apparatus regardless of its size or character. The regulation has been in operation but a short time, and we have found several very hazardous conditions existing, particularly where ammonia apparatus has been placed in basements with insufficient exits and close by ovens and open flames, which might ignite explosive vapors that are frequently present in ammonia apparatus as the result of oil generally found in such systems.

We are endeavoring to enforce the regulation in a reasonable manner.

We find in every instance, that although the machine be under three tons capacity, the owners are pleased to have us see that someone is designated as a fit person to have charge of such apparatus.

At a hearing in Massachusetts the builders of small-capacity machines acquiesced to five tons as maximum to be operated by an unlicensed man. It is all very well to say that if ammonia refrigerating machinery is unsafe, it is no concern of the public's what economic suffering may be inflicted upon the builders and the operator, so long as public danger is lessened to the minimum. But as the workable solution of most problems in every channel of human effort is had only by compromise, this refrigeration situation must finally be made agreeably stable by compromise. The dollar's might continues undiminshed. The apartment house, market or other place where small machines are now operated by the janitor or butcher boy must, if a license law sets the exempted capacity too low, employ another comparatively well-paid man to handle what the janitor has heretofore managed. The solution plainly lies in compelling such small machinery to be provided with sufficient safety devices, approved by the law-enforcing board or body, to insure, as far as is reasonable, safety from accidents to such equipment.

FIG. 4. SHOWS HOW FRACTURE FOLLOWED WELD

The ammonia safety-valve rules of Massachusetts (effective 1915) are still the subject of considerable comment, favorable and unfavorable. Here again the dollar is the underlying cause. Assume that a builder, particularly a builder of small machines, guarantees the installation for a period long or short. Many such machines as installed in apartments, hotels, etc., use city water tapped off the house supply at any convenient place for condenser purpose. With safety valves provided as required by Massachusetts, it needs only that there be a heavy demand for water throughout the house, and of a duration not unusual, for the condensers to be lacking water long enough to increase the discharge pressure, opening the safety valve and blowing out the charge of ammonia. This happens not infrequently, and with ammonia at 26c. per lb., the purchaser immediately demands that the builder make good the charge lost. Certainly this matter is one for adjustment between seller and purchaser and does not concern the law-enforcing body or others, because it is easily preventable mechanically.

Leaky safety valves are another source of disturbance among owners and builders under the Massachusetts rules. And the chief cause of complaint is the loss of ammonia occasioned by the leaking valve. Of all the valves returned to the manufacturer of by far the greater number of safety valves used for this purpose in Massachusetts, red lead, pipe scale, and dirt lodging in the valve, have been the cause of the leakage. Obviously a valve, even though it seats only on a line, will not seat if it comes down on these foreign substances. The legislator would very properly regard this complaint as not entitled to a hearing because the trouble is preventable by reasonable care, which any safety device should receive.

It is probable that the percentage of explosions in ammonia refrigerating plants is small. Statistics, carefully gathered, would show that while there is no need for alarm, on the whole, state or municipal regulations are desirable; further, they would reveal the most common causes of explosions, and in this way lead to quick treatment of the most serious defects. Then too, perhaps the surest and quickest way of gathering such statistical matter with the greatest accuracy is through the agency of a law-enforcing body or board, to which all explosions in the jurisdiction are usually required to be reported.

John E. Starr, of the Starr Engineering Co., 90 West St., New York City, who is now collecting information about explosions of ammonia apparatus finds, so far as he has carried his investigations, that a considerable percentage of such explosions is due to shutting off from the system a vessel containing ammonia, such as a receiver or cooler. The liquid ammonia in such a closed vessel expands, of course, and fractures the container. The art would be benefited if reliable particulars concerning ammonia explosions past and present were to be forwarded either to *Power* or to Mr. Starr, where such accidents could be classified and further investigated, as in this way the profession would have tangable data to guide it in the work of minimizing such explosions.

⁂

**Of the World's Production of Copper** the United States produces about 60 per cent. and consumes about 41 per cent., which is approximately 2,211,000 lb. About 30 per cent. of the metal in the ore is lost in concentration, which means that in this country alone in 1914 about 340,000,000 lb., worth approximately $50,000,000, went to the tailings pile.

## Pipe-Line Dead Ends

One of the most serious oversights in the design and operation of pipe lines is allowing undrained dead ends. Both design and operation are mentioned because closing a valve at a low point may produce a condition identical with that of simply blanking off the end of a pipe extending beyond the last drain point. A case vividly in mind was where an 8-in. steam pipe line was extended about 25 ft. and blanked off at the end during a week-end shutdown, preparatory to connecting up another boiler later. When steam was raised and turned into the line, several heavy water-hammer blows were heard; then a final one, more severe, knocked the new section loose from the flange and hangers so that it fell to the floor. The cause was obvious; the extension dipped slightly and had no drain, so that the condensate collected in the end and as the pressure and heat increased, water-hammer was set up. Had there been an open drain, the water could not have accumulated.

As previously referred to, this condition can be and frequently is duplicated in the operation of lines. Valves are closed to segregate some part of the system, and when steam is again turned on, no provision is made to drain out the water at the low points and sometimes a disastrous accident follows. The remedy is so obvious that it hardly need be stated; namely, drains and brains.

Drains are not sufficient without the exercise of judgment to avoid their being overtaxed in capacity. Condensation goes on at a rapid rate when steam is first turned into a cold pipe, and a drain large enough to take care of a long line into which the steam is admitted rapidly would be entirely too large for reasonable service and therefore is to be avoided. As a rule, drains should have steam traps attached if used at all after the line is in active service, but drains used only when "cutting in" are best allowed to blow outboard and in plain view of the operator, otherwise there may be a stoppage that is not suspected. For the same reason all drains having traps attached should also have another or blow-valve opening to be used during the warming-up process. Turning steam on too rapidly causes other excessive strains, but that is another story.

In handling valves on water lines, especially of the quick-acting type, care must be exercised to avoid water-hammer. This form of water-hammer is considered to be of somewhat different character from that set up in steam lines. It is easily understood when, for instance, the force of, say, 1,000 lb. of water flowing at 400 ft. per min. is expended almost instantly against the obstruction or retainer. It can be compared to the blow of a battering ram of equal weight and velocity. Moral: Open and close valves gradually and provide drains to take care of the condensate in the one case and afford relief in the other.

⁂

**For Determining Specific Heat of a Gas at Constant Volume** the Jolys steam calorimeter may be used. A large globe containing W grams of compressed gas is immersed in steam at atmospheric pressure and at the temperature corresponding thereto. Some of the steam is condensed in raising the temperature of the globe and the gas through (T) degrees. Then allowing for the heat used in warming the globe and knowing the weight (w) of water condensed and the latent heat of steam (970.4), the specific heat (S) of the gas is given by the formula $S = \frac{w \times 970.4}{W \times T}$. This method, however, requires very delicate weighing and is used chiefly in laboratory practice.

# Editorials

## The Conservation of Coal

England is uneasy about her coal supply as related to that available in deposits. Speaking before the British Association, engineering section, Dr. Dugald Clerk stated that after studying the coal reserves of the earth he concluded that at the present rate of consumption industrial civilization would not last more than five thousand years, and that for England not more than five hundred years.

Of course any one with enough imagination to be truly human can see possibilities of serious industrial disturbances as the coal supply begins to approach the last few tons in the bin. But nearly everyone who calculates how long it will be before this condition exists bases his figures on present methods of mining and consumption. But the waste of coal will continue to become smaller and smaller in proportion to its consumption. Think of the enormous savings being effected in modern power plants. Dr. E. F. Armstrong, who spoke at the meeting of the British Association and who is associated with a company that uses coal tonnage running into seven figures, stated that by careful insulating his company had saved as much as a thousand tons a week. This seems an enormous saving to be made by insulation. Scientific management of the power plant, particularly of the boiler room, will have a tremendous influence on the annual coal consumption. The reclamation of piles of mine refuse shows that with increasing coal prices human ingenuity will find means for using what in times of greater plenty was regarded as fit only for the dump. When suitable firebrick is found, powdered coal for boilers will make possible the utilization of this refuse coal with combustion closely approaching the theoretical.

Speaking of economy in the production of electricity, Sir Charles Parsons emphasized the influence of large-sized units, meaning boilers and turbo-generators. This reminds us of the savings which the thirty-five thousand-kilowatt turbines for the Seventy-fourth Street station of the Interborough Rapid Transit Company, New York City, have effected over the notably economical reciprocating engines they replaced. For the same output each of these turbines effects a saving of approximately two hundred and forty tons (two thousand pounds) of coal per day, based on twenty-four-hour operation. Indeed the steam turbine has been so thoroughly developed that the talk of water power has lost a good deal of the enchantment it used to lend to "white coals." Today there is building in the very shadow of the great Niagara, where no money outlay was required for a dam, a steam-driven central station.

It is likely, too, that the chemist will before long convince the public of the value of coal and crude petroleum for chemicals, and when recognition of their value for such commodities becomes reasonably well established in the public mind, deplorable waste of coal and oil for engineering purposes will halt with a jerk.

Industrial civilization may pick up the razor, but it will never cut its own throat—not while science is its Hebe.

## Piston Rod Design

Recently the high-pressure piston rod of a cross-compound engine in the plant of the Clark Thread Company, East Newark, N. J., broke through the keyway at the crosshead end, the rod being a taper fit into the crosshead and held tight by a key. This is the second accident of the same nature that has happened to two different engines at these mills. Fortunately no one was injured or killed in either accident. Breaking of piston rods of this construction, while perhaps not so frequent as to be alarming, happens often enough to warrant questioning the safety of this design. We have heard erectors of engines having this style of piston rod state that they have broken the end off the rod when keying; and these engineers are considered careful workmen.

To begin with, the very nature of the design—sharp corners at a point where the rod tapers down, the weakest part of the rod—lays the rod liable to fracture. If the key works loose, the force of the blow delivered by the heavy reciprocating parts of the engine falls upon this weakened part of the rod. If the engine gets a "dose" of water on the crank end, the rod at the small end, where the cross-section measured through the keyway is less than that of any other part likely to be subjected to such stress, must stand up against this suddenly applied shock or break—and when a piston rod breaks on an engine in motion, things usually happen to the rest of the engine.

In these days of safety engineering, workmen's compensation and employers' liability laws, the builder and the engineer cannot be too critical about the design of machinery such as that used in power plants.

## The Steam Separator

The steam separator generally works on the principle that the water particles are heavier than the surrounding steam particles and, being carried along with the steam, they have therefore greater momentum. If the direction of flow is changed suddenly, the water particles will tend to continue in a straight line and can be collected in the lower part of the separator body where there is no velocity and whence the condensed steam can be trapped off. Other types are so constructed that the wet steam is given a whirling action and the heavier water particles are thrown to the outside and allowed to drain quietly to the bottom. Even in these separators the direction of flow is usually reversed. Both of these types of separators are quite effective in removing moisture and in providing the engine with commercially dry steam, especially in the case of high-pressure steam.

However, the direction of flow cannot be changed suddenly nor can the steam be given a whirling motion without the expenditure of a certain amount of its energy, and the effectiveness of a pound of such steam in a turbine is decreased by exactly this amount of wasted energy. It is true that in the average case this may be a very small

percentage of the total energy; nevertheless it is energy lost.

How can this water be removed from the steam without whirling or reversing action? In studying this problem, one must keep in mind the true action of wet steam flowing in a pipe. The wetness of the steam may be due to two factors—the actual water of condensation, flowing generally along the walls of the pipe, and the minute suspended particles of vapor resembling fog in the flowing steam. Condensation due to radiation losses takes place principally on the walls of the pipe, and there is no logical reason why the moisture resulting from this condensation should permeate the steam that is flowing at the center of the pipe.

Some years ago after observing the performance of wet steam and superheated steam passing through a glass pipe, a noted engineering professor advanced the theory that the moisture due to condensation all adheres to the pipe and flows along the bottom if the velocity is very low or in spirals about the pipe if the velocity is sufficiently high or after bends or elbows. This opinion was verified later by a series of tests on a large main of a heating system. A small search tube was employed having a single hole that could be adjusted to any position in the pipe. It was found that either water or very wet steam passed along close to the sides of the pipe, while the inner core of steam was practically dry. The depth of the film of wet steam along the walls of the pipe decreased with increase of the steam velocity.

If such is generally the action occurring in straight piping, then all that should be necessary is to provide some device that will allow the inner core of dry steam to pass through directly and only the outer ring of wet steam need be carried to a separating chamber, which in its simplest form may be a modification of a water-leg. There is probably considerable mixing of steam and water in elbows, but where long-radius bends are used, it is probable that the water still sticks to the edge of the pipe, especially along the outer radius of the bend.

When one is dealing with low-pressure steam, the question of steam separators is very important. In one of the large Western plants, in which low-pressure steam turbines are used with Corliss engines, considerable difficulty has been experienced in securing dry steam from the separators. In the discussion of the recent paper by Messrs. Stott and Finley, on the tests of the Interborough's thirty thousand-kilowatt cross-compound steam turbine, it was pointed out that the efficiency of the turbine was improved over one per cent. by removing all the baffles from the separator, which had been placed between the high- and low-pressure cylinders. In this case the steam from the high-pressure cylinder carries its moisture in the form of fog, and it cannot therefore be efficiently removed. The separator also offered such a resistance to flow that the energy represented by a drop in pressure of two and eight-tenths inches of mercury was lost in overcoming it. Some large turbines using two cylinders, but of later design, have no separators at all, for the steam passes directly from the high-pressure cylinder into the low-pressure cylinder.

It is therefore in order to suggest to engineers that some attention and study be given to the types of separators in use in their plants and to improved means of dealing with moisture in wet steam. The complete separation of moisture from low-pressure steam is still an unsolved problem for engineers.

## Decline of the Gas Engine

A few years ago gas engines were receiving wide attention from American engineers and several large plants were almost entirely devoted to their manufacture. Descriptions of new designs and improvements of old models appeared with great regularity in the technical press, and large gas engines were installed at many blast-furnace plants. In fact, gas engines were enjoying a real boom. But at present there are few large units being built and installed. One company which was a pioneer in gas-engine building has practically abandoned such construction, and with a few exceptions, as in the natural-gas belt, other builders have difficulty in finding business. It is pertinent to inquire, Why this change in popularity?

There appear to be several contributing causes. The supply of natural gas, which proved an ideal fuel for such power generators, has diminished in certain sections, which fact has naturally led to the replacement of gas engines in some plants by other types of prime movers—usually boilers and turbines. Some of the gas engines built from the earlier designs were subject to inherent weaknesses and their operation was not entirely satisfactory. Consequently, the repair and maintenance charges were relatively high, although counterbalanced to a large extent by low fuel costs. Moreover, the development of oil engines of the Diesel and semi-Diesel types has introduced formidable competitors to the gas engine in certain sections of this country.

Probably the greatest factor in the decline of the gas engine has been the rapid development of the steam turbine in all sizes and types. Managers of plants are attracted by the low first cost, the increasingly high steam economy, the uniform reliability and the simplicity of operation of modern steam turbines. With gas engines one needs, as an operator, a man who has considerable skill both as an engineer and as a mechanic. Steam turbines are simple to run and seldom need other attention than the regrinding of valves and the care of the oil system; hence, operating engineers favor such units rather than the ones involving much hard work.

With these considerations in mind, one can speculate regarding the future possibilities for gas engines. At present the probabilities are that the steam turbine will continue to increase in favor and also that oil engines will be more widely adapted. However, there is one factor that may alter the situation in some localities, and that is the rapidly increasing adoption of systems for byproduct-gas manufacture. These make cheap gas production in quantity possible, and when such gas is available, gas engines may be used advantageously as a source of power in many small industries; but the cost of electric power from central stations is also being reduced, and this factor may offset the low fuel costs of gas engines, even with cheap gas.

It would therefore seem that gas engines have had their greatest popularity unless some great improvements can be made in their design so as to produce cheaper and more reliable machines or to provide more economical operation.

What is the use of putting instruments in the boiler room if the men do not know how to use them or, if they do know, have no incentive to use them?

# Correspondence

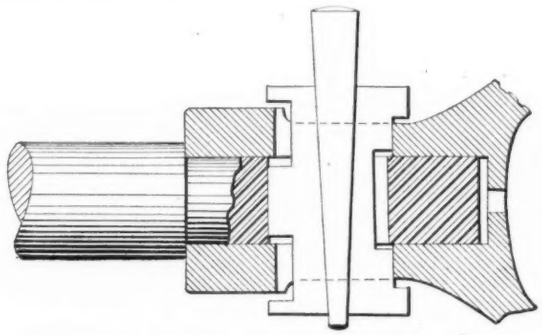
## A Bell-Ringing Transformer Made from a Spark Coil

Anyone wishing to make a bell-ringing transformer may do so by using an old spark coil, which may be obtained from almost any auto-wrecking company at about one-third what it will cost to make one. By removing a few turns of the primary winding a very satisfactory transformer can be made. I have one which cost $1.50 and after removing two layers of the primary winding, it would ring a bell, buzzer, light a 1.5-volt lamp and run a toy motor. This scheme may be of use to someone wishing to do away with dry batteries.

Redondo Beach, Calif. L. L. NEWCOMB.

## To Loosen Crosshead from Rod

Hammering on the crosshead to loosen a piston rod disfigures it considerably. Two gibs, one with an additional projection pressing against the rod and the second



SPECIAL GIBS TO DRIVE PISTON ROD OUT

with a notch cut out opposite the projection on the other side, inserted and driven apart by a suitable wedge or cotter, as shown in illustration, will loosen the rod without doing any damage whatever. JAN SPAANDER.

Brooklyn, N. Y.

## Water Too High in the Boiler

Brown, No. 3 watch engineer, was eating his lunch, and Malloy, the fireman, was cleaning fires for the last time on his "trick." The door between the engine and boiler rooms was shut, but Brown could see, through the frosted-glass door, the steam clouds rising from the hot ashes as Malloy turned water on them preparatory to wheeling them out.

Suddenly No. 4 engine, back of where Brown was sitting, began to "buck." It was a high-speed, piston valve, horizontal engine, directly connected to an alternating-current generator, carrying a full load. Brown started in the direction of No. 4, which was carrying on in a manner calculated to startle even him, who on account of his disinclination to get excited in any emergency, was known to his workmates as "Old Steady."

Yes, No. 4 was "bucking" like a broncho trying to unseat its rider. The engine, which had a rated speed of 360 r.p.m., would run steadily for a few seconds, and then suddenly it would slow down, almost stopping; then, with a lurch which apparently no machine could withstand, it would speed up as quickly as it had slowed down a moment before. A distinct "thud," sometimes sharp and sometimes dull, could be heard at each stroke as the engine slowed down, but there was no unusual noise perceptible as it came up to speed again.

Brown's first thought was, "Governor stuck." That seemed hardly possible, however, for only that evening he had gone over the governor carefully before starting the engine. The "thud" that accompanied each stroke of the piston came apparently from the cylinder, and he turned his attention in that direction. A shutdown was unthinkable except as a last resort, and Brown was willing to take almost any chance in order to prevent it. Opening the cocks had the effect of lessening the "clack-clack" in the cylinder, but the engine continued to "buck" with only slightly reduced severity.

It was now clear that the difficulty was water in the cylinder. Leaving the drain cocks open, he hastened to the boiler room. A glance at the boiler gage-glasses confirmed his suspicion. No. 3 boiler had no alarm whistle on the water column, and the glass showed no line of demarkation between water and steam. Literally, the boiler was overflowing through the cylinder of No. 4 engine.

"Malloy," shouted the engineer as he grasped the situation, "is there any water going into No. 3 boiler?"

"No, sir."

"Well, don't let any in until you can see it in the glass."

"All right, sir."

"And say, Malloy, when you are through with the ashes, come to the desk a minute, will you? I want to show you something."

"Aye, aye, sir."

Half an hour later Malloy presented himself at the engineer's desk. No. 4 had tamed down again, and Brown was waiting for him. Handing him a copy of the morning paper, he told him to read an item that he had marked for his benefit. Taking the proffered paper, Malloy read:

ENGINEER KILLED

Cylinder Head Blows Out of Engine, Killing One and Partly Wrecking Building

Shortly after 8 o'clock last evening the cylinder head blew out of a Corliss engine in the plant of . . . According to the information obtained at the office of the company, the engineer was directly in the path of the broken cylinder head and the escaping steam from the open end of the cylinder. When found he was scalded almost beyond recognition, death probably having been instantaneous. According to the reports so far given out, the accident was caused by water from the boiler flooding the cylinder.

Malloy finished the account. He knew now why his chief had called him into the engine room. Looking up, he found Brown regarding him with a sober look on his face.

"Must have been a terrible death," began the engineer.

Malloy said nothing.

"No. 4 has automatic relief valves on the cylinder drain lines. No. 1 does not have them. If I had been running No. 1 tonight, I might have had the same thing happen to me that happened to that unfortunate man last night. Do you know, Malloy, that No. 4 stood more racking abuse tonight than I ever thought any engine could possibly go through and come out whole. Those automatic cylinder relief valves saved her—and maybe me."

"The water got up out of sight before I noticed it." Malloy was plainly worried, for this was the nearest to a "call-down" he had ever received from his running mate. "I had no idea it was so high until just before you came into the boiler room, and then I shut it off as soon as I could."

"I have warned you before about carrying too much water," said the engineer, not unkindly, "but it seems to be your one failing. You should make a special effort to watch yourself in this respect, for just as sure as you don't, if you stay in the boiler room long enough you will get somebody into serious trouble, to put it mildly. Always bear in mind that too much water in the boiler is apt to cause disastrous results, as well as too little. The casualty you just read of demonstrates it in a concrete manner and should be a lesson you."

No more trouble was had with water in the cylinders as long as Malloy fired. H. G. GIBSON.

Washington, D. C.

## Oil Burning Boiler Furnace

In the issue of Sept 26, page 464, W. G. Camp describes an oil-burning furnace for return-tubular boilers, which he says gives excellent results, but I feel doubtful of its excellence. It looks to me like a lot of good brick and labor wasted in the construction of walls and air ducts, and a fine chance of blistering the boiler.

No doubt it is desirable in burning coal to change the direction of the gases so as to give them a better opportunity to mix with the air, but with oil it is different, as the nature of the atomized fuel permits a ready mixture with air. All that is then required for complete combustion is a high temperature and plenty of furnace space in which perfect combustion may take place before the gases come in contact with the cool surface. A return-tubular boiler furnace should have the grates bricked over tight, except a space of 3 or 4 sq.ft. directly under the burner, which should be covered with soapstone or brick laid checkerboard fashion, leaving out every other one. These should be supported by bars or heavy strap iron and not by the regular grates. The air is then admitted in the usual way, through the ashpit doors, which are sometimes used to regulate the supply. The bridge-wall should be taken out and the furnace allowed to extend the full length of the boiler. In my opinion the flame should be directed toward the rear in a horizontal position, and under no conditions should it be directed against the boiler plates, because the intensity of the flame will bag a boiler very quickly, as has often been done.

In one case two return-tubular boilers that have previously burned wood were equipped with oil burners, the flames of which were directed against the boiler plates. Within 12 hours both boilers were badly bagged. Perhaps it has not been necessary for Mr. Camp to crowd his boilers, hence the favorable impression, but I would not care to be responsible for his boilers if they are to be crowded with the present furnace.

Home-made burners may be all that is claimed for them, but as a general rule they prove to be poor economy—a saving in the first cost but a continual waste thereafter. There are numerous reliable companies that manufacture good economical burners, which are designed by experts who make a study of atomization and are sold at reasonable prices. Nearly all the uptodate plants where economy is the watchword, use standard burners. A. C. MCHUGH.

Del Monte, Calif.

## Reply to a Dissatisfied Diesel User

While not now engaged in oil-engine operation, I was for several years in charge of plants operating oil engines, both horizontal and vertical, but never did I have such experiences as described by H. R. Wass in the Oct. 10 issue, page 535.

I handled one engine over two years with never a shutdown outside of regular Sunday stops and at no expense for repairs in that time. This engine was run weeks at a time, taking care of a heavy overload on the peak at night and the surges of a large induction-motor load in the daytime. Its operation in parallel on alternating-current service was unexcelled by any steam plant. Bearings were taken up once in about six months, and they were not bad even then.

The remarks about changing rings would mislead the inexperienced into believing that this was an operation that must be performed weekly instead of at remote periods, as is the case.

In regard to the amount of attention required, there are at least twenty points in a steam plant that require looking after to one in a Diesel plant—a matter with which I am familiar, having operated both.

Such has been my experience with the type so severely condemned by Mr. Wass, and other Diesel operators in this state are doing as well if not better. I believe manufacturers are partly to blame in many instances where the Diesel engine suffers and gets a bad name, because they often advocate cheaper help than is found in a steam plant, when in fact it requires a man of just as broad experience in gas engineering and consequently commanding as good wages for his services. C. DICKERSON.

Glenwood, Minn.

## Viscosity in Cylinder Oil

Having followed the discussion in *Power* in regard to the testing of lubricants, I have become much interested.

In the issues of Apr. 11 and July 18, Charles E. Carpenter condemns our present methods of testing, but offers no remedy. In his article of Apr. 11 he states: "The property of adhering to wet surfaces at high temperatures is the only one worth considering, and yet the buyers of cylinder oils, in endeavoring to protect themselves by specifications, never treat of this subject at all." He further states: "The flash and fire test amount to nothing, and viscosity is a humbug."

I agree with him that the property of adhering to wet surfaces is one of the most essential points to be considered, but desire to correct him in his statements that

flash and fire amount to nothing and viscosity is a humbug.

During my experience in the testing of lubricants, I have never met anyone of any knowledge in testing oils who could properly apply the right oil to any condition without taking the flash, fire and viscosity into consideration. Adding animal oil or fat to mineral cylinder oil will greatly improve its adhering qualities; nevertheless, it is important to know what class or grade of mineral oil is being compounded with animal oil or fat.

It appears to me that Mr. Carpenter has made the same error that I have observed in numerous persons interested in the testing of lubricants by applying the viscosity test too directly. It seems that one will either consider that viscosity indicates lubricating merit or will condemn it as being misleading. I do not believe there is any authority who claims that viscosity indicates lubricating merit. They will, however, consider it a necessary test to be made along with other physical tests. Viscosity is not necessarily applied to mineral oil or lubricating conditions only, but is frequently applied to animal and vegetable oils to assist the chemist in classifying them.

I wonder if Mr. Carpenter in purchasing mineral oil with the following approximate specifications: Gravity, 25 to 26 deg. Baumé; flash, 560 deg. F.; fire, 620 deg. F.; viscosity, 190 deg. at 212 deg. F. Sayboldt; would be satisfied to accept an oil with a viscosity of 160 deg., the other tests being the same? In some instances viscosity indicates superior quality; in others, inferior quality. In either indication the conclusion is arrived at by the viscosity test being taken into consideration with other tests.

Because Mr. Carpenter has come to realize that adhering property is an essential factor, it does not give him just cause to condemn our present methods of testing.

He made the statement that he is debating for the benefit of science. Condemning the present methods without offering improvements or new methods does not benefit science. We should endeavor to assist one another to get the most out of our present methods or offer suggestions for improved or better ones. Our practices can stand improvement, and I do not doubt that there are many persons interested in the testing of lubricants who are deliberating over improvements; but let us not condemn our present methods until we succeed in finding better ones.

It is impossible to decide upon the proper lubricant by taking only one of the physical tests into consideration, but weighing them all, one in accordance with another, enables one to arrive at the proper conclusion.

The tests discussed in this article are not the only ones to be considered, but if any one of the tests discussed is eliminated from our present methods, we would be at a loss. With our present knowledge, I do not understand how any company can guarantee uniform goods without employing the methods discussed.

In Mr. Carpenter's article of July 18, he says, "It is an extremely difficult undertaking to take the viscosity at temperatures above 212 deg. F." I surmise that he based this statement upon the fact that water is used to heat the oil to the desired temperature in taking the viscosity. It is simple to heat the oil to a greater degree than the boiling point of water by using an oil bath. He also states: "In taking the viscosity of an oil in the Sayboldt apparatus, or any other constructed with a similar tap faucet, it will make a difference of as high as twenty points if the window happens to be open near the instrument and a draft blows on the faucet." Let us hope that we are competent to operate viscosimeters or other apparatus under proper conditions.

Another statement he made: "Some of the cylinder oils well known and generally accepted by the profession as being of the highest grade are not of the highest viscosity and will not show the highest viscosity if taken at temperatures of use." Certainly; viscosity cannot be directly applied as an indication of lubricating merit.

Mr. Carpenter cannot adulterate the viscosity of a lubricant so that it cannot be detected in any laboratory. The idea of giving a lubricating oil an artificial viscosity is a past one. It was practically given up when the profession realized that high viscosity did not *necessarily* improve the lubricating quality.

Regarding Mr. Carpenter's statement, "There is nothing in the physical test that reproduces the physical condition under which the cylinder oil is to lubricate," I do not believe there has been any assertion made by any authority that suggested an attempt to directly compare them.

I want to extend my compliments to J. Motion in appreciation of his article in *Power* of Aug. 15.

L. W. Jaeger, Chemist,
Milwaukee, Wis. Bartles-Maguire Oil Co.

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It seems, in reading over the subject matter of the discussion now going on in *Power* concerning the relation of viscosity of cylinder oils to lubricating value, as though each one has a case of his own experience as a practical application for his arguments, neglecting generalizations.

As has been generally understood, viscosity is a good indication of lubricating value for forced-feed lubrication. Experiments show that if a journal be supplied with sufficient oil to maintain a film between the relatively moving surfaces, the lost work will be in direct proportion to the absolute viscosity of the lubricant. Hence forced lubrication approaches the ideal conditions in that the journal is supported upon the oil film and no metallic contact takes place.

Viscosity is clearly seen to be an indicator of the friction where a sufficient supply of oil is at hand to prevent metallic rubbing. The remedy, therefore, for friction of the moving metallic parts is the presence of enough oil to keep them apart. To establish the film, however, it is found that the quantity of oil to be supplied varies inversely with the viscosity of the lubricant; that is to say, a smaller amount of a high-viscosity oil will lubricate as well as a larger amount of low-viscosity oil, neglecting the loss of power due to internal friction of the lubricant.

If, therefore, a cylinder oil is to lubricate properly, it must form the required oil film between the piston and the cylinder wall. The effect of oil is undoubtedly the same in the cylinder as it is in the bearing. Since, in the bearing, it has been experimentally proved that viscosity plays an important part, there is every reason to believe that the viscosity of cylinder oils is a point worthy of consideration.

It is this last idea which does not meet with the approval of some who have discussed the subject. But if the laws of friction and lubrication apply so well to bear-

ings, why can they not also be applied to the lubrication of steam cylinders?

Of course the results cannot be absolutely predicted by viscosity values, for there are some conditions that are entirely peculiar to steam-cylinder lubrication. For instance, a straight nonemulsifiable mineral oil can hardly be used because of its tendency to leave the surface of the cylinder when that surface has been wetted by the water of condensation or entrained water in the steam. Here also some discussion may arise as to whether the emulsion will act the same in regard to friction loss as the straight oil. The water in the emulsion does not, in this case, act as a lubricant. Only the friction of the oil particles, one upon the other, causes the loss due to the internal friction of the lubricant, and that of the water may be neglected. The oil particles also act as the means of holding the surfaces apart, the water having no sustaining power in this case. The oil, therefore, is considered as the sole source of lubrication, the emulsifying action being merely to allow the oil to stay on the wetted surface, without any chemical change taking place in it.

Some adulterants are used which increase the viscosity of the oil at low temperatures, but this artificial viscosity is lost at the high temperatures of the cylinders. These adulterants have no lubricating value, for although they are apparently viscous, they do not possess the cohesive properties of oil. A mixture of mud and water may be very viscous as measured by a viscosimeter because of the great resistance to flow, but it is far from being a lubricant. It is therefore necessary that other tests be used in conjunction with viscosity when selecting an oil.

The object of this short discussion is not to prove absolutely the relation of viscosity to steam-cylinder lubrication, but rather to call attention to the similarity of the requirements for good lubrication in any system. The facts stated concerning forced-feed lubrication are well known to be true, and it seems reasonable to believe that with due consideration of chemical analysis and working conditions they should also apply to steam-cylinder lubrication.

H. R. SMITH.

Annapolis, Md.

## Leaky Transformer Cases

In the Oct. 10 issue of *Power*, M. A. Walker gives his experience with leaky transformer cases and the use of a carbonate of lime cement with a top coating of shellac.

The writer's experience with leaky transformer cases, due to cracks, sand holes or defective castings, has shown that a thorough permanent and therefore satisfactory repair can be made by temporarily filling or calking the aperture with the carbonate of lime cement or substitute to stop the flow of oil, and applying over this and the adjacent surface a coating of glycerin and litharge worked up into a paste of about the consistency of soft putty. While it is well to have the surface to which this is to adhere clean and bright, it is not absolutely necessary to do so, for it possesses remarkable bonding properties. A repair of this nature cannot, of course, be made where the tensile strength of the parts has become impaired.

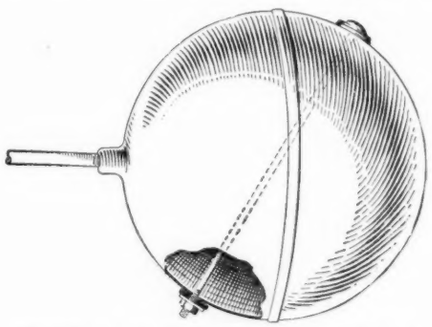
Many transformer leaks may be traced to the effect produced by capillary attraction; that is, the oil creeping up the conductors to the outside of the case. Manufacturers usually cut away the insulation of the conductors for a small space immediately above the surface of the oil to prevent this, but sometimes a film of oil may be established over the copper conductor in the space and defeat the object sought. This usually occurs when the transformer is located in a warm place. Frequently, if this film is broken by wiping the conductors dry, it will put an end to the annoyance.

MATHEW KING.

Clifton, N. J.

## Repairing a Leaking Float

A float-type trap draining one of our dry-kiln coils recently became inoperative, and examination showed that the copper float had become water-logged through a small pinhole. It was soldered over and the trap put in service, but it soon ceased to work for the solder did not hold. We



FLOAT REPAIRED WITHOUT SOLDER

then fixed it as shown in the illustration. The original hole was reamed out to about ⅛ in., and another hole was drilled in the float directly opposite. A long slender bolt was then put through the float and clamped down on two washers made of sheet packing. A tight joint was thus made, and the float has been behaving satisfactorily ever since.

M. A. SALLER.

Philadelphia, Penn.

## Boiler Side-Wall Construction

If any reply has been made to Ormand Wilson's very important suggestion on "inclosing the sides of shells of return-tubular boilers," in the issue of June 13, page 850, it has escaped my notice. This matter of so closing in the side walls as to form a gas-tight chamber is of more consequence than many engineers seem to realize.

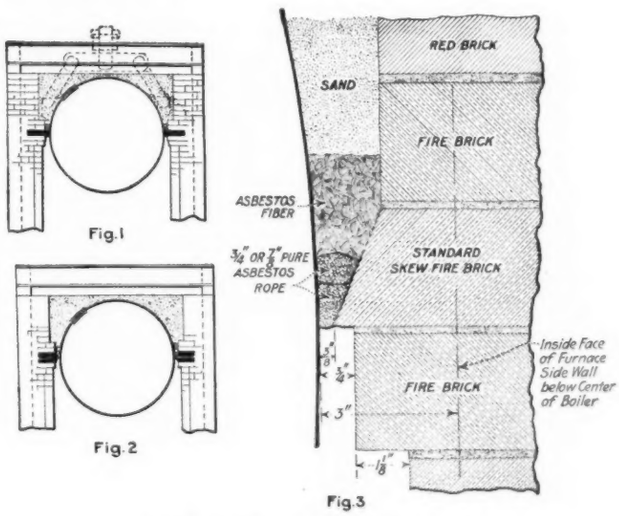
Our engineers are devoting their energies to determining the sizes of shell and tubes, kind of seams, bracing, character of furnace, etc., varying in this or that feature among constructors just enough to remind us of the old days when we had all shapes and sizes of screw threads. The question of setting a boiler and bricking it in so as to best perform its functions is ignored, and they (some, not all) stop short, leaving that work to the rigger and the mason, who in days past were presumed to know more about the setting and bricking-in of boilers than anyone else. The man who built the boiler did not assume to know much about the subject and cared less, while the man who sold it was glad to let someone else look after its installation. So it has gone on for many years, but now constructing engineers are questioning many things that go to make up an efficient boiler unit. There is a more general practice of suspending boilers from steel

gallows frames, known as the three-point suspension system, instead of throwing all the weight of boiler and piping upon the brickwork of the setting, and to delegate this form of construction to the mason would be unwise. Therefore the engineer getting into the problem finds that one question after another arises for decision, until finally they represent a complete working plan, from the foundation to the uptake flue.

One of the most important features is the matter of closing in a boiler. The illustrations show the method I am using, Fig. 1 by means of a single skew-brick course and Fig. 2 with a double course of skew-brick. I find Fig. 1 satisfactory, but Fig. 2 has features that may be better. Fig. 3 is the mason's drawing for a setting skew-brick course and corbeling it over and represents a section of Fig. 1 enlarged.

One of the difficulties in getting a mason to corbel his brick over against the shell of the boiler is because of his disposition to anchor the shell at some part that should be free. Habit is strong with us all, and if there is anyone to be found in which it is stronger than in a brick mason, I would like to see him. My object in this closing-in design is to give the mason standard brick to work with and no chipping to do.

To get a ⅜-in. or any desired clearance between the point of the skew-brick and boiler shell, I require a




CONSTRUCTION OF SIDE WALLS

Fig. 1—The single skew-brick and Fig. 2 the double skew-brick construction. Fig. 3—Enlarged section of Fig. 1

wooden slat to be used, against which the brick is brought. Nothing could be more simple, and it will add just one tool to the mason's kit.

Cutting a length of asbestos rope to the length of this fore-and-aft slot, putting it in place from above and tamping it down into the wedge-shaped orifice are simple operations. Throwing in and tamping down a small quantity of loose asbestos fiber and filling in with sand is all that remains to be done, and when finished, it forms a gas-tight packing that eliminates the crowding of the side walls and allows for the normal movement of the boiler.

Asbestos rope is frequently more readily obtained than asbestos of long fiber and is much more easily and accurately distributed along the shell, especially if the side wall may by chance have been run up many courses before the asbestos is brought onto the job.

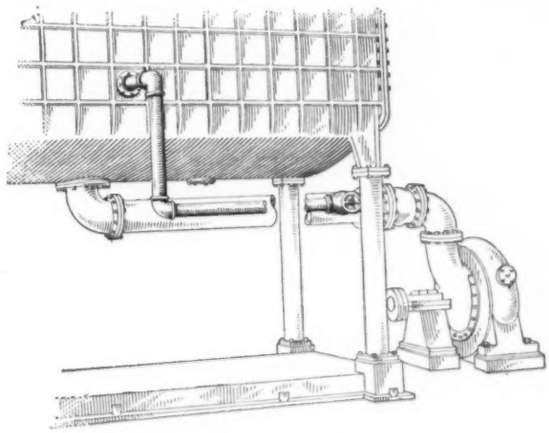
I use brick with an inch skew, as it seems to be just the taper required, but on a pinch one can chip a skew on common firebrick that will answer very well. I know of one case where this was done under stress of time, but to provide a smooth standard skew-end brick is the best practice.

Working the asbestos rope under the suspender brackets, or side-wall brackets if such supports are used, is easy and simple, even in a dim light or no light at all, as the sense of touch is sufficient to do the work.

New York City. OROSCO C. WOOLSON.

## Centrifugal-Pump Trouble

Turbine-driven centrifugal pumps deliver the condensed steam from the condenser into an open heater in our plant. Strict attention being always paid to the pump glands,



EQUALIZER ON PUMP SUCTION LINE

no trouble was experienced so long as the generators did not much exceed full load, 2,000 kw. each. The machines, however, often had to carry about 30 per cent. overload for hours at a stretch. Then the pumps failed to handle all the condensate and it gradually rose in the condenser. When the water reached the inlet opening to the dry air or vacuum pumps, it passed through the pipes, flooded and stopped the pumps. Increasing the speed of the centrifugal pumps had little effect. Finally, to equalize the vacuum a 1¼-in. pipe connection was made from the condenser to the centrifugal pump suction handling the condensate, as shown in the illustration. This connection proved so satisfactory that, when installing a 5,000-kw. unit, a similar connection was put on it also.

Vancouver, B. C. T. J. BURNS.

## Water Level Reflector

I have made a gage-glass reflector that seems to be quite a novelty among the engineers in this locality. Some of them have nicknamed it my "barber's sign." It is easily made and will be found of help in showing the height of water in the gage-glass in dark places and even when the glass is dirty or the water a little muddy. It is made from a piece of tin or zinc 4 in. wide and as long as the gage-glass. It is first painted white and then striped diagonally with red, like the familiar barber pole, the red stripes being ⅜ in. wide and 1 in. apart.

If a piece of asbestos paper is fastened to the back of the tin or zinc, it will help keep the heat away; the heat turns

the paint yellowish. Or instead of using common paint, after applying one coat of flat white, paint with enamel such as is used on metal bedsteads. This paint is made to stand the heat and will last a long time before turning yellow.

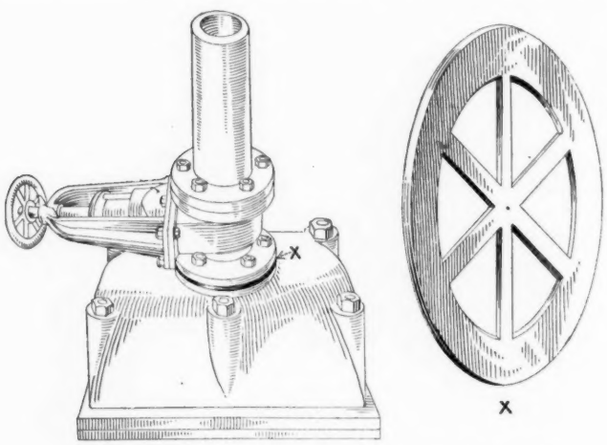
Make two little holes at one end of the plate and put a small wire through them and hang on the upper glass connection between the water column and the glass. The water in the glass will show the stripes in the opposite direction. Where there is no water, the stripes will hardly show at all. WALTER E. ROBINSON.

Amherst, Mass.

[Readers of *Power* will recollect that in the issue of Feb. 15, 1916, page 216, there was described and illustrated a "reflector" identical to Mr. Robinson's, except that Mr. Wines, the maker of the one previously described, used black instead of red stripes. The following from the description of Mr. Wines' "reflector," or more correctly, water-level finder, is interesting: "The inventor says the idea came to him by accident. To produce a clear background for a dirty glass, he used the side of a fancy pasteboard box having diagonal lines much the same as those used on the indicator. To his surprise the lines appeared horizontal below the water level." Those who attended the recent Minneapolis convention of the National Association of Stationary Engineers will remember that Mr. Werbeck, of the Durabla Co., exhibited a similar reflector. —Editor.]

## To Catch Loose Pump Valves

Some such a strainer as that shown on page 485 in the issue of Oct. 3, or perhaps like the accompanying illustration, should be used in the discharge line of a boiler-feed



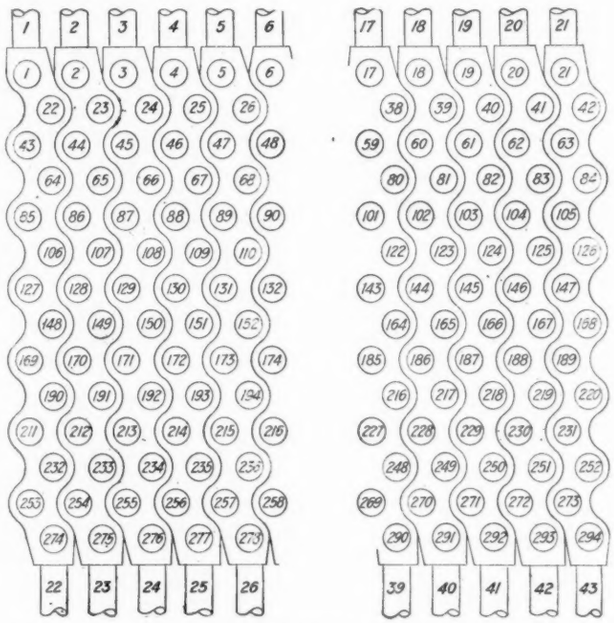

STRAINER IN FLANGE JOINT NEXT TO PUMP

pump, as it will save a lot of trouble. If any of the pump valves work loose, they are apt to get lodged in the pipe line or some of the valves. The best location for a strainer is next to the pump, but the one shown can be placed between flanges anywhere. It is made out of a sheet of brass or bronze cut to the diameter of the inside of the bolt circle and the web openings or perforations made of sufficient size not to obstruct the flow of water by decreasing the area of the pipe. We consider such strainers entirely satisfactory after several years of use on different pumps. CHARLES W. WATKIN.

Dorranceton, Penn.

## Record of Boiler Repairs

I keep a record of work done on our water-tube boilers of the B. & W. type by means of a diagram of the headers, nipples and tube ends pasted in the 8½x10½-in., 200-page boiler logbook. To get the number of a tube I count the headers from the side and the tubes down from the top and look on the chart; if it is the 21st header and second tube down, it will be No. 42. I keep a record of all tubes and nipples renewed or rolled. If, after being rolled several times, one continues to leak, I conclude that it has been rolled too thin and it is time to renew it. In some of our boilers we have put in all new nipples in the mud



MEANS OF IDENTIFYING BOILER PARTS FOR RECORDS

drum in the past four years, and those that have not been renewed will probably need to be at the next overhauling.

These charts can be made for almost any size and most makes of boilers, and the same principle can be employed to keep a record of tubes in economizers; it is very important to know how many tubes there are in a section in case a new top or bottom header is needed.

The first section of the book has three pages for each boiler for records of tubes, nipples, headers, etc. The next section contains the same space devoted to each furnace, record of side and bridge walls, arches, jambs and fronts and a note of the brand of firebrick and fireclay used. In that way I can tell the amount of service I get, and in making any changes in material it is easy to make comparisons. The next section has twenty pages for each boiler. I make a memorandum of the time the boiler is in and out of service, the work done on it, the conditions of tubes and drums on inspection and any other information I want to keep. It is not a very hard job, and it is worth a lot for reference. C. B. SMITH.

Framingham, Mass.

**A Remarkable Property of Manganese Steel** is its almost total lack of magnetic permeability and susceptibility. This metal, containing 85 per cent. of iron in a metallic form, is so slightly attracted by a magnet that the pull cannot be felt with the hand, whereas magnetic oxide of iron, containing about 70 per cent. of iron in a nonmetallic form, is strongly attracted.—Bulletin No. 100, U. S. Bureau of Mines.

# California Boiler Orders

The Boiler Safety Orders issued by the Industrial Accident Commission of California, effective Jan. 1, 1917, are now being circulated. The Boiler Code of the American Society of Mechanical Engineers has been adopted almost in its entirety, the exceptions applying only to existing installations. The orders are as follows:

Order No. 800: Inspection—(a) All steam boilers operated in the State of California, except those exempt by (b) of this order shall be subject to a regular internal and external inspection each year, if in service at any time during the current year, except that an interval of 14 months may be allowed when necessary.

(b) Exemptions: The following boilers are exempt from inspection by the Industrial Accident Commission: (1) Boilers under the jurisdiction of the United States; (2) boilers of railroad locomotives used in interstate commerce and boilers under United States inspection; (3) boilers used exclusively for agricultural purposes; (4) boilers of 12 hp. or less on which the pressure does not exceed 15 lb. per sq.in.; (5) automobile boilers and road motor vehicles.

(c) Whoever owns or causes to be used a boiler subject to inspections shall report the location of such boilers to the Industrial Accident Commission of California on Jan. 1, or within 30 days thereafter of each year.

(d) The owner or user of a boiler or boilers herein required to be inspected shall, after 14 days' notice, prepare the boiler for internal inspection or hydrostatic pressure test, if necessary. To prepare a boiler for internal inspection, the water shall be drawn off and the boiler thoroughly washed; all manhole and handhole covers[1] and washout plugs in boilers and water-column connections shall be removed and the furnace and combustion chamber thoroughly cooled and cleaned. Enough of the brickwork shall be removed to determine the condition of the boiler, furnace or other part at each annual inspection. The steam gage shall be removed for testing.

(e) If it is found that steam or hot water is leaking into the boiler, the source of such leakage shall be disconnected and so drained as to cut out such steam or hot water from the boiler to be inspected.

(f) If the boiler is jacketed so that the longitudinal seams of the shells, drums or domes cannot be seen, and if it cannot otherwise be determined, enough of the jacketing, setting walls or other covering shall be removed so that the size and pitch of the rivets and such other data as may be necessary can be determined at first data inspection.

(g) In preparing a boiler for hydrostatic test, the boiler shall be filled to the stop valve; if boiler to be tested is connected with other boilers that are under steam pressure, such connection shall be blanked off unless there are double stop valves on all connection pipes with an open drain between.

Order 801: Insurance Inspections—All boilers subject to periodic inspection by insurance companies authorized to insure boilers in the State of California shall be exempt from regular annual inspection by the Industrial Accident Commission on the following conditions:

(a) The insurance companies' regulations shall conform to the orders herein: (b) The insurance companies' inspectors who inspect boilers operated in this state shall hold certificates of competency, issued by the Industrial Accident Commission, as hereinafter provided.

(c) Reports of all inspections shall conform to the requirements of this commission and shall be made upon the forms provided.

(d) A copy of all annual reports shall be forwarded to this commission within 21 days after the inspection is made on the forms provided.

(e) Insurance companies whose inspectors hold certificates of competency shall immediately report to this commission the name of the owner or operator and the location of every boiler on which insurance has been refused, cancelled or discontinued, giving the reason therefor.

Order 802: Special Inspections—(a) Steam boilers within the regular corporate limits of counties and cities which are regularly inspected by an authorized county or city inspector, and steam boilers operated or controlled by companies or corporations which receive regular annual inspections by an inspector employed by the said companies or corporations, shall be exempt from the regular inspections made by this commission on the following conditions:

1. The boiler shall be installed and equipped with the fittings necessary to safety, as prescribed by the orders.
2. The inspector or inspectors shall hold certificate of competency issued by the Industrial Accident Commission or be duly authorized as deputy inspectors.
3. The reports of all annual inspections shall conform to the requirements of, and a copy of said reports shall be forwarded to this commission within 21 days after the inspections are made, on the forms provided.

Order 803: Certificate of Competency—(a) Upon the written request of an employer certificates of competency shall be issued to persons who are employed as provided in section (c), and who pass an examination prescribed by the Industrial Accident Commission. Such examination shall determine the fitness and competency of candidates for said certificates[2].

(b) A certificate of competency may be revoked for cause at any time, but the holder of such certificate of competency shall be entitled upon demand to a hearing before the Industrial Accident Commission before the revocation of such certificate.

(c) A certificate of competency shall be issued only to a person who is or is to be employed as inspector only by any county, city, corporation or company and shall be annulled upon the termination of his employment by the said city, county, corporation or company by which he is employed at the time of the issuance of the certificate. Such certificate may, however, be renewed without reëxamination within a period of one year upon proof that the applicant has been reengaged as a boiler inspector.

1. Any applicant who fails to pass the examination may apply for a reëxamination at the end of 90 days, provided, however, that a person who has been refused a certificate of competency may appeal from such decision to the Industrial Accident Commission, who shall grant a rehearing. The applicant shall have the privilege of having one representative of the county, city, corporation or company by whom he is or is to be employed, present during the hearing.

(d) Upon the request of an employer the commission may permit an employee after passing the prescribed examination, to act as deputy inspector. Such deputy inspector may inspect and issue certificates of inspection for only such types of boilers as shall be specified in his permit. Such deputy inspector's permit shall be subject to the same terms of revocation, annulment and renewal as specified in (b) and (c) of this order.

Order 804: Annual Inspection Certificate—(a) A certificate of inspection upon the form supplied by the Industrial Accident Commission shall be issued by the inspector in the employ of the county, city, corporation or company stating the pressure allowed for one year after an inspection has been made. This certificate shall be kept conspicuously posted under glass in the engine or boiler room and shall at all times be available when called for by a deputy of this commission or by an inspector holding a certificate of competency.

(b) The pressure allowed as stated in the certificate of inspection shall not be in excess of that determined by the orders for boilers installed prior to Jan. 1, 1917.

Order 805: Stamps and Numbers on Boilers: (a) The owner or user of a steam boiler shall number each boiler in some convenient and permanent manner.

(b) Boilers installed after Jan. 1, 1917, shall be stamped by the builder with a serial number, date of manufacture and his name, in accordance with the orders herein.

(c) Boilers built after Jan. 1, 1917, shall conform with these orders, and before being placed in service shall be inspected and a certificate of inspection issued.

Order 806: New Types of Boilers—(a) Builders of new types of boilers subjected to inspection shall forward to the Industrial Accident Commission blueprints and specifications of the types for approval.

Order 807: Safety Regulations—(a) No boiler shall be operated at a pressure in excess of the safe working pressure allowed by the annual inspection certificate, which pressure is to be ascertained by means of these orders.

Order 808—(a) Boilers of 12 hp. or less, on which the pressure does not exceed 15 lb. per sq.in., which are exempt from annual inspection, shall be fitted with such appliances as shall insure safety, as herein prescribed.

Order 809—(a) Any boiler in this state at the time these orders take effect which does not conform to the herein orders, may be operated, if found safe, after a thorough internal and external inspection, and a hydrostatic pressure test, if necessary.

(b) No new power boiler shall be installed in the State of California after these orders take effect which was not stamped when built by the manufacturer, with the American Society of Mechanical Engineers' Boiler Code stamp, except after a joint inspection by the Industrial Accident Commission and another inspector holding a certificate of competency. The lowest factor of safety on boilers of this kind shall be six, except that all new boilers carried in stock in this state on or before Jan. 1, 1917, by dealers or private owners, may be installed after these orders take effect, using a factor of safety as stipulated for existing installations, provided that they shall be equipped with all the necessary appliances to comply with the herein orders as laid down for new installations. Provided further that new boilers built prior to the date these orders go into effect, under the supervision and to the regulations of the Interstate Railroad or the Interstate Commerce Commission may be installed and placed in operation, under these same provisions.

Order 810—(a) Steam boilers shall be equipped with such appliances as will insure safety of operation as herein ordered.

Order 811—(a) No person shall remove or tamper with any safety appliance prescribed by the herein orders, and no person shall in any manner load the safety valve to greater pressure than that allowed by the certificate of inspection.

Order 812—(a) In case a defect affecting the safety of a steam boiler is discovered, the owner or user of the boiler shall immediately notify the inspector issuing the certificate of inspection, but if said boiler is not subject to annual inspection, the owner or user shall in that case report the defect to the Industrial Accident Commission. The boiler shall not again be placed in service until the defect has been remedied.

Order 813—(a) All patches on a boiler, shell or drum which exceeds 24 in. in length measured in a line parallel to the longitudinal seams and between the central lines of the extreme rivet holes shall be calculated by safe working pressure from said patch seam, the efficiency of which shall be determined in the usual manner.

The efficiency of the patch seam may then be increased by a factor which is determined by the angularity of the inclined patch seam to the girth seam according to the following table:

| Angle, Deg. | Factor | Angle, Deg. | Factor |
|---|---|---|---|
| 30 | 1.51 | 50 | 1.20 |
| 35 | 1.41 | 55 | 1.15 |
| 40 | 1.34 | 60 | 1.11 |
| 45 | 1.27 | 65 | 1.08 |

Order 814—(a) No cast-iron hot-water heating boiler shall carry a greater pressure, static or from supply main, than that named in the guarantee of the manufacturer, and in no case shall the pressure exceed 30 lb. per sq.in.

[1] As a rule in water-tube boilers it will be sufficient if such as are necessary of the two lower rows of tubes be removed.

[2] Candidates will be examined as to their knowledge of the construction, installation, operation, maintenance and repair of steam boilers and of the rules covering boilers in California.

Order 815—(a) Where it is found impossible to definitely determine the age of a boiler of lap-seam construction, the factor of safety shall be not less than 5½.

(b) No pressure on a boiler of lap-seam construction shall exceed 165 lb. per sq.in.

Order 816—(a) The use of plug cocks so constructed that there is no band or yoke to hold the plugs in place will not be allowed. If yokes or bands are of the open-hole slot type at both ends, they shall have said cocks effectively closed.

Order 817—(a) Where boiler settings are so designed that gas can accumulate to a dangerous extent provision must be made for venting said gas pockets.

(b) All dampers used in connection with oil-burning furnaces under steam boilers shall be made with or have suitable opening therein to vent the furnace from an accumulation of gas. Suitable explosion doors or similar devices will be considered as carrying out the provisions of this order.

Order 818—(a) If there are valves in the connections between water column and boiler at least one steam gage shall be connected directly to the steam space of the boiler with but one cock between the said gage and the boiler.

Order 819—(a) In determining the size of safety valves the following table showing the ratio of heating surface to horsepower shall be used:

| Type of Boiler | Water-Heating Surface-for 1 Hp., Sq.Ft. |
|---|---|
| Cylindrical | 9 |
| Flue | 10 |
| Firebox-tubular | 12 |
| Return-tubular | 15 |
| Vertical | 15 |
| Water-tube | 10 |

Order 820: A. S. M. E. Boiler Code—(a) The Boiler Code, Edition of 1914, with index, of the American Society of Mechanical Engineers, as copyrighted in 1915, is made a part of these orders with certain changes and additions, all of which said changes and additions refer only to existing installations.

RULES APPLIED TO HEATING BOILERS

Order 821: Steam Heating Boilers (Existing and New Installations, Fittings and Appliances)—(a) There shall be a stop valve on each steam outlet from the boiler except the safety-valve connection.

(b) When a damper regulator is used, it shall be connected to the steam space of the boiler and there shall be a stop valve or stop cock in the connection pipe.

(c) The main return pipe to a heating boiler (gravity-return system) shall have a check valve and also a stop valve between the said check valve and the boiler. When there are two connected boilers with a gravity return system, one check valve may be placed on the main return pipe and a stop valve on the branch pipes to each boiler.

(b) Each boiler shall have a feed pipe fitted with check valve and also a stop valve between the check valve and the boiler. The feed water to discharge below the lowest safe water line. Means must be provided for feeding a boiler against the maximum pressure allowed in the boiler.

The Code of the American Society of Mechanical Engineers then follows. (See editorial in "Power" for last week, for comment on exceptions and changes in Boiler Code made in the California orders.)

# Convention of the New England Section N. E. L. A.

The eighth annual convention of the New England section of the National Electric Light Association was held at the Maplewood Hotel, Pittsfield, Mass., Oct. 17-19, attended by about 500 members and guests. The convention was informally opened on the evening of the 17th with a reception followed by a dance in the ballroom of the hotel. With the exception of the second day, which was rainy, the superb autumn weather of the Berkshires added zest to outdoor recreations and sight-seeing for members and guests who could spare time from the routine business of the convention. Automobile trips were made by a number of guests to the summit of Greylock Mountain, and visits of inspection were made by several parties through the local General Electric plant.

GROUP OF DELEGATES TO CONVENTION OF NEW ENGLAND SECTION

The entertainment committee arranged golf and tennis tournaments at the Country Club of Pittsfield, and some fine prizes, mostly electrical devices, were offered by companies of Pittsfield and other places. On Wednesday evening the convention was entertained by a sprightly program of recitations and music rendered by "Judge" Vredenburgh, of the Boston Edison Illuminating Co., and others.

At the close of Wednesday morning's session the following officers, named by the nominating committee, were elected for the ensuing year: President, R. W. Rollins, Worcester Electric Light Co., Worcester, Mass.; vice-president, A. B. Lisle, Narragansett Electric Lighting Co., Providence, R. I.; treasurer, Bowen Tufts, C. D. Parker & Co., Boston; secretary, Miss O. A. Bursiel, Boston; executive committee, A. H. Ford, Portland, Me.; R. D. Smith, Keene, N. H.; E. E. Larrabee, Bennington, Vt.; C. R. Hayes, Fitchburg, Mass.; George B. Leland, Stamford, Conn., and S. B. Tuell, of Pawtucket, R. I. The retiring president, W. S. Wyman, of Augusta, Me., is a member, ex-officio, of the executive committee.

The sessions of Wednesday, Oct. 18 were devoted mainly to papers and discussions on industrial heating and large power propositions. The papers presented were: "Obtaining Large Power Business," by W. C. Durant, New England Power Co., Worcester, Mass. "Obtaining Large Power Business," by Warren B. Lewis, consulting engineer, Providence, R. I. "Determining Demand of Large Power Users," by R. S. Hale, the Edison Electric Illuminating Co. of Boston. "Use of Central Station by Large Power Users," by David Elwell, Lockwood, Greene & Co., Boston, Mass. "Industrial Heating," E. F. Collins, General Electric Co., Schenectady, N. Y. These were followed by the report of the Heating Research Joint Committee of the New England section of N. E. L. A. and the National District Heating Association.

The sessions of Thursday were given to reading of papers and discussions coming under the report of the Accounting Section Committee, Public Policy Committee and addresses by members of State Public Service Commissions, and the convention program was concluded Friday morning by the reading and discussions of papers presented by the Commercial Section Committee.

R. S. Hale's paper on "Demand and Load Factor Systems" gave the results of an analysis and comparison of a number of systems. The work was started as a result of a conference between four important New England interests. Each of the four companies submitted data of one or more of its actual customers, with the intention that the demands of each customer should then be computed by the systems of the other

companies, so as to determine for these actual cases what difference there was in the systems of determining the demands independent of any differences in prices.

After describing eleven different systems of charging and showing the results extended over several months, the author stated that obviously there is no definite connection between the various systems in charging for the maximum demand. Even on any particular customer whose business was the same year by year, the results by the different systems might be different purely by accident. For instance, if the customer had four very heavy days during the year—if these by accident all came in the same month of one year but came in different months of the next year, it would make a great deal of difference which system was being used for computing the billed demand.

Although the systems usually come within 10 per cent. of one another for normal large power customers, yet it would never be safe to assume that they would come even within 20 or 40 per cent. for any particular customer. "Do we want to do anything about it; that is, do we want to make any arrangement that all the different companies throughout New England or throughout the United States shall use the same method?"

The author stated that the paper was presented as the result of a suggestion that the various companies might be able to get together on some agreement; but personally he was doubtful whether any such agreement would be practicable; in the end discussion will lead to uniformity on some points, and this will be better than any formal agreement.

In his paper on "The Use of Central Station Service by Large Power Users," Mr. David Elwell said:

Studies of the cost of purchased and privately generated electric power for industrial plants of good size made by the concern with which I am associated indicate that power rates are often based on the private plant's probable power cost rather than the central station's; that is, the latter charges all that the market will stand.

It is perfectly proper for central stations to sell commercial power at any price they see fit—or to keep it. I, however, believe that, based on the actual costs of central-station energy, they can sell it at a profit cheaper than the private industrial plant can make it. This does not mean that private power plants will cease to be built—the manufacturer requiring electric power is still often confronted with the condition of stiff power rates in spite of the theory of low central-station costs. I believe central stations can make a large power rate that proper analysis on the manufacturers' part will show is generally wise to accept.

In some sections rates are already so low that manufacturers are glad to take advantage of them and the possibility of private generation is not entertained. In some cases, however, existing rates and the complication introduced by steam requirements for manufacturing or heating make a careful analysis necessary to determine the best course. Even a steam demand does not always bring salvation to the private plant. The heating and power demands by no means synchronize, and often the parts of the plant requiring steam in the process require little or no power, or are sometimes inoperative when the electrical load is on, or are operative when there is no demand for electric power. The part that the central-station manager should play in the evolution of the science is to hasten the day of almost universal central-station service by quoting large power rates that will make it no object for the manufacturer to seek his power elsewhere.

A factory with a respectable power plant already on its hands is a hard nut for the central station to crack. The investment which it represents must be carried whether it runs or not, and central-station power cannot compete unless it costs less than the private plant's operating charges. Power companies are making big drives for this class of business, but a rate good enough to get it is considerably better than would as a rule be required to keep the private plant out in the first place. Inefficient apparatus or the need of replacement makes this class of work less difficult, but the power solicitor with a fair rate has a much easier row to hoe in going after new jobs than existing plants.

The reasons why the central station is able to sell power at a profit at less than private costs are wholly a matter of economics; namely, lower fixed and operating charges. A kilowatt-hour of central-station energy can sell for less than one from a private plant because the investment and running costs to produce it are very much less. Considering operating costs, the central station has the advantage of lower steam consumption and less labor cost per kilowatt. H. G. Stott expects to get 1 kw.-hr. for 10.5 lb. of steam from 70,000-kw. units for traction purposes in New York.

The labor cost per kilowatt is obviously much less for the central station than the private plant. There is not much more to take a man's time on a turbine of large size than a small one, and the plant crew increases very slowly as the number of units increases. The purchase of coal at low wholesale rates and to specification is in favor of the central station.

Warren B. Lewis in his paper, "Obtaining Large Power Business," recited details of the methods that were employed in securing the patronage and satisfactory service of current required by a hotel for light and power.

Actual tests were made to show which boilers were the most efficient to operate under the conditions of both summer and winter loads, just what pressures should be carried on the heating system, just what pumps should be used in one location and what in another, what the economical speed was of ventilating fans, just how the men's work should be laid out so that they could fire coal at one time and draw ice out of a refrigerating tank at another, etc.; at the end of nine months the net saving over the previous costs of operation was $4,900.

What is the explanation of the success of the plan in the cases referred to?

In the first place, probably the most important element is that of supervision. It is rare to find good technical direction for power-plant operations, except in those industries where power is of first importance. It is hardly to be expected that in an industry where the cost of power represents but a small percentage of the value of the business done there should be attached to it the importance which it deserves. Furthermore, it is not often that an isolated plant can afford to employ the kind of supervision that is really needed. It requires a peculiar kind of service to get the very best efficiency out of a plant that is made up of a great mixture of machinery and piping systems, and it is doubtful whether that service can be supplied except from a central organization that can divide its time, and hence its expense, over a number of plants.

Another very important point, and one but poorly understood, is the relation between the production of power and the subsequent use of exhaust steam for other operations. There is no greater fallacy than the time-worn argument used in so many cases, that practically all the exhaust steam is used for one purpose or another. In nine cases out of ten, careful study will show that a very small proportion of the exhaust steam made in producing power is subsequently used economically. That term is used with deliberate intent because, more often than not, ways and means are found for using exhaust steam simply because it is available, whereas, if the matter had been approached from the proper standpoint, the object would have been to have made as little exhaust as possible, and then use it to the best advantage.

In the case of this hotel, the operating company found that room temperatures could be maintained with far less steam than had ever been used before. It took some training to have radiators turned off in rooms that were not occupied, to adjust steam pressures and vacuum to out-of-door temperatures, to turn steam on the side of the house where the wind was blowing the strongest, etc.; but having done this, the net result was to reduce the amount of steam used in the heating system to one-half of that which had been previously collected in the form of condensation from the vacuum pumps.

The third element of success is good organization. The plan as suggested, in order to be successful, must be carried through by an operating force that specializes in that kind of work. It is a plan of great detail; it requires the most intimate knowledge of every machine and pipe and valve and wire in the plant under direction, and it requires a thorough knowledge of the market for supplies and specialties and good purchasing ability; but, after all, none of these things is difficult of accomplishment, and where the demand for such an organization exists, the supply will be forthcoming.

NATIONAL ELECTRIC LIGHT ASSOCIATION, HELD AT PITTSFIELD, OCT. 17-19

There are, of course, plants of considerable size where the operations are not varied, such, for instance, as a manufacturing plant where power is produced through the use of highly efficient engines and boilers, and where there is very little else than the production of power, that the central station may not be able to reach quite yet; but there are a surprisingly large number of plants in which the actual production of power is but a comparatively small part of its activities, and the real hope for the central station is to show how that plant can be operated as a whole to save money. Perhaps it does not sell current simply because it costs less than power made on the premises, and perhaps it may have to engage in a considerable operation to gain an entrance; but whatever the underlying reason may be, if the owner is satisfied that he is paying out less money than he was before, he is pretty apt to look upon the public-service corporation as a benefactor and be quick to show his appreciation.

W. C. Durant's paper on "Obtaining Large Power Business," which will be reviewed in a subsequent issue, was highly commended for its exposition in detail of methods used in a specific case.

The Heating Research Committee is a result of certain isolated-plant discussions that took place at the meeting of the New England Section of the National Electric Light Association at Kineo, Me., in the fall of 1915, when it was charged by a representative of a large manufacturer operating an isolated plant that central-station companies were long on information as to electric costs and operation, and by clever salesmanship and otherwise, solicited the electric-light and power business, but after getting the electric business left the customer, in many cases, without any advice or assistance as to the operation of his steam-heating requirements.

The report of the committee is supplemented by descriptions of various classes of buildings and data of their heating plants, electrical data and annual unit consumption of coal per square foot of floor space and per 1,000 cu.ft. of volume.

## PERSONALS

**J. H. Honey,** first assistant engineer with the Hill Publishing Co., will sail on Oct. 28 to assume a similar position with the Figardo Sugar Co., at Fakardo, Porto Rico.

**E. W. Petter,** chairman and managing director of Petters, Ltd., the well-known British marine and stationary oil-engine builders, is on a visit to this country with the idea of establishing an American branch for the production of the Petter engine.

**Henry R. Cobleigh,** until recently managing editor of "Power," has formed the Power Plant Management Co., with Walter N. Polakov, consulting engineer and formerly superintendent of power for the New York, New Haven & Hartford R.R. Co., to specialize in the introduction of scientific methods for the operation of power plants. The company's headquarters are in the National Bank of Commerce Building, 31 Nassau St., New York City.

**Barrett Smith,** advertising engineer of Boston, has arranged to spend part of his time at 65 Duane St., New York, this step having been made necessary by the extension of practice in this territory and the middle west. Mr. Smith specializes in the advertising of structural products and machinery more particularly in connection with large construction projects, the trade literature which he has produced covering many of the well-known developments of recent years. He was appointed by Stone & Webster and the Massachusetts Institute of Technology to manage the electrical division of the recent industrial exhibition held in connection with the dedication of the New Technology Buildings at Cambridge, and which was described in "Power," of June 27.

## ENGINEERING AFFAIRS

**Mercer Council, Universal Craftsman Council of Engineers,** Trenton will listen to a talk on "Steam Flow Meters" at its next regular monthly meeting, Nov. 11.

**The Western Society of Engineers,** Chicago, on Nov. 6 will listen to an address by A. S. Zinn on the "Construction of a Narrow Gage Railway in the Republic of Panama."

**The Irish-American Engineers' Association** will hold its annual entertainment and ball at Prospect Hall, Brooklyn, N. Y., on Nov. 4. An entertaining program has been arranged and the committee promises a good time.

**The New York, New Haven and Worcester Sections, A. S. M. E.** are planning an inspection trip to the plant of the Electric Boat Co. at New London, Conn.; the tentative date being Nov. 11. At this plant are built Diesel engines for submarines and arrangements are being made with the Navy Department to have submarine diving and maneuvers for the benefit of the visitors.

## Proposed Construction

**Ala., Huntsville**—Alabama Power Co., Birmingham, plans enlarging its plant. J. A. Sirnit, Birmingham, electrical engineer.

**Conn., Winsted**—Winsted Gas Co. plans to build an electric power plant on South Main St. and will also extend its power lines to Torrington, Conn.

**Fla., Titusville**—Southern Utilities Co., Jacksonville, purchased plant of Titusville Electric Light Co. and will spend about $15,000 for improvements.

**Ga., Augusta**—R. J. Edenfield and associates applied to Council for franchise for electric-light and power system in Augusta.

**Ill., Bloomington**—City officials and proprietors of factory buildings plan central power plant to furnish light and power to manufacturing concerns.

**Ill., Gillespie**—Southern Illinois Light and Power Co. plans power plant at Gillespie. About $25,000.

**Iowa, Marshalltown**—Atlas Disposal Works plans to build two reinforced-concrete and brick boiler houses, estimated to cost $15,000.

**Iowa, Spencer**—City plans election to vote on $50,000 bonds for improving and extending electric-light plant and system.

**Iowa, West Chester**—Citizens voted bonds for electric-light plant.

**Kan., Bronson**—City plans to install an electric-light plant and system.

**Kan., Independence**—Western States Portland Cement Co. to rebuild power plant destroyed by fire with loss of $100,000. C. B. McVay, manager.

**Kan., McPherson**—Central Academy and College making plans for one-story heating plant. F. D. Rixse, 212 South Clarence St., Wichita, architect.

**Kan., Reserve**—Citizens voted $7,000 bonds for distribution system.

**Mass., Springfield**—William Carter Co. making plans for one-story boiler house, 60x60 ft. About $40,000. Henry M. Hope, Boston, engineer.

**Mich., Vasser**—City voted $25,000 bonds to improve electric-light plant.

**Minn., Adams**—City plans electric-lighting system.

**Mo., Kansas City**—Kansas City Light and Power Co. making plans for heating plant. About $12,000.

**Mo., Pleasant Hill**—Plans are being prepared for rebuilding the electric-light and power plant, also building new power house and smoke stack. Estimated cost, $10,000. L. K. Green & Sons, owners.

**Neb., Crete**—Fairmount Creamery Co., 12th and Jones St., Omaha, is having plans prepared by H. Lawrie, architect, Omaha, for a one-story 60x110-ft. brick, steel and concrete power house. Estimated cost, $8,000.

**N. J., Jersey City**—Swift & Co. plans to build an addition to its plant on Henderson St.

**N. Y., Andover**—City to hold election Nov. 17 to vote on $6,000 bonds for addition to the electric-light plant.

**N. Y., Hornell**—Hornell Electric Co. plans electric transmission lines to Arkport and Canaseraga.

**N. Y., New York**—(Borough of Bronx)—Interborough Rapid Transit Co., 165 Broadway, is receiving bids for the construction of a one-story 60x100-ft. brick power house at 139th St. and Alexander Ave. Estimated cost, $40,000. G. H. Pegram, 165 Broadway, architect.

**Ohio, Tiffin**—County plans new boiler house and heating plant, about $10,000. Address clerk, Tiffin.

**Ohio, Urbana**—Northwestern Ohio Light Co., Urbana, plans transmission line from Urbana to Westfield.

**Okla., Cumby**—George Holland has purchased the local electric-light plant and plans to improve same.

**Okla., Stroud**—City soon to receive bids for improving electric-light plant and system. About $7,000. Benham Engineering Co., Colcor Bldg., Oklahoma, engineer.

**Ont., Leamington**—Town Council plans improving light and power system. R. M. Selkirk, clerk.

**Ont., Niagara Falls**—Town Council contemplates an expenditure of $11,485 for additions to its electric power plant. J. W. Seymour, clerk.

**Penn., Philadelphia**—Barrett Manufacturing Co. plans to improve and enlarge boiler room. W. B. Murphy, Market and Bermuda St., in charge.

**Que., Montreal**—The Howard Smith Paper Co. will build an addition to its power plant. Estimated cost, $10,000. R. S. Kelsch, Power Building, Montreal, is architect.

**S. C., McCormick**—M. G. and J. J. Dorn applied to Council for franchise for electric-light plant. About $12,000 or $15,000.

**S. D., Garrison**—Citizens recently voted $18,000 bonds for reconstructing municipal electric-light plant.

**Tex., Jacksonville**—Jacksonville Electric and Ice Co., recently incorporated with $90,000 capital stock, plans electric-light plant and ice factory in Jacksonville. R. W. Baker, Palestine, interested.

**Utah, Salt Lake City**—Utah Power and Light Co. plans electric transmission line to Pacific property, American Fork Dist. M. Cheever, Salt Lake City, engineer.

**Vt., East Middlebury**—Bread Leaf Mountain Power Co. plans hydro-electric plant. About $300,000.

**Va., Fork Union**—Fork Union Military Academy plans to install electric-light plant.

**Wis., Eau Claire**—Wisconsin-Minnesota Light and Power Co., Eau Claire, plans to extend transmission lines through Alma.